

COMBINED CONGRESS

Annual congress of
SSSSA, SASHS & SASCP

WHAT IS THE NEW NORMAL
FOR AGRICULTURE
TO ENSURE SUSTAINABLE
LIVELIHOOD IN AFRICA?

WAT IS DIE NUWE NORMAAL OM
VOLHOUBARE LEWENSONDERHOUD
IN AFRIKA TE VERSEKER?

Aanlyn kongres / Online congress

17-23 January 2022

Viewing of abstracts and posters

25-27 January 2022

Combined Congress (live sessions)

<https://combinedcongress.org.za/>



COMBINED CONGRESS 2022 – PARTICIPATING SOCIETIES
GESAMENTLIKE KONGRES 2022 – DEELNEMENDE VERENIGINGS



South African Society of Crop Production
Suid-Afrikaanse Vereniging vir Gewasproduksie

E-mail: admin@sascp.org.za
Website: www.sascp.org.za



Soil Science Society of South Africa
Grondkunde Vereniging van Suid-Afrika

E-mail: admin@soils.co.za
Website: www.soils.org.za



Southern African Society
for Horticultural Sciences
Suider-Afrikaanse Vereniging
vir Tuinbouwetenskappe

E-mail: admin@sashs.co.za
Website: www.sashs.co.za

ACKNOWLEDGEMENTS / ERKENNINGS

Thank you to:

The editors of the three societies for their role in the finalising of the accepted presentations and posters;

The reviewers for all the different categories for their assistance with reviewing all the abstracts;

Nancy Nortjè for liaising with all roleplayers to ensure that everyone was happy; and

Landbouweekblad for their invaluable contribution to make this online version (our first) possible of the Combined Congress.

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PLEASE TAKE NOTE

All oral presentations (videos) will be available for viewing in Crowdcast – please check your e-mail for the links.

Questions about video presentations: Click on Ask a Question in Crowdcast to post your question/comment about a specific presentation.

All poster presentations (PDF's) will be available for viewing in PDF booklets – please check your e-mail for the attachments.

Questions about posters: Please e-mail your questions for the Q&A sessions to Dr Johann Strauss at JohannSt@elsenburg.com. Please indicate the poster number and session.

Deadline for submitting of questions: Saturday 22 January 2022 @ 11:00

Enquiries: events@landbou.com



GENERAL INFORMATION ATTENDING THE CONGRESS

VIEWING OF PRESENTATIONS – 17-23 JANUARY 2022 (first week)

1. You will only get access once you have registered for the conference via Quicket or e-mailing *Landbouweekblad* at events@landbou.com – please type Combined Congress 2022 in the e-mail's subject field.
2. Once registered and payment was received, you will receive a Quicket ticket with your access links. This will grant you access to both the online viewing part of the congress, as well as the online live sessions with the keynote speakers and question and answer sessions.
3. All the pre-recorded online content will be available from Monday 17 January 2022 until midnight on Sunday 23 January 2022.
4. You may ask questions or make comments when viewing each of the oral presentations and posters. The questions will be presented to the presenters of these presentations and posters at all the live sessions during the second week of the conference.

LIVE SESSIONS – 25-27 JANUARY 2022 (second week)

1. Each day of the conference will start at 09:00 precisely. Please be online and logged in five minutes before the event starts.
2. Each day will begin with a keynote speaker of one of the participating societies, followed by three question and answer sessions. Each society will have one session per day.
3. Please note that all presenters of oral presentations and posters must be online to answer possible questions during one of the sessions during the three congress days. Please see the programme to confirm for which session you need to be online.

SACNASP

1. If you would like to receive CPD points, please take note that you will be awarded 0,1 points per hour you attend. To obtain 1 full point you will have to view 24 presentations. If you are attending all the sessions during the second week, you will be rewarded with 1 point.
2. To claim your CPD points, please send an e-mail to nancynortje@icloud.com with the following information:
 - Name and surname
 - SACNASP membership number
 - The e-mail address that you have used to access the online congress



POSTERS									
SASHS ORAL PRESENTATIONS									
	SASHS poster session		Session 1		Session 2		Session 3		Session 4
			Biotechnology, Breeding, Propagation, Nutrition, Water Mangement & Crop Protection		Indigenous, Medicinal Plants; New & Alternative Crops		Production & Cultivation Practices		Physiology & Post-Harvest Biology
Number		Number	Title	Number	Title	Number	Title	Number	Title
H33	HARD SEED COAT THE DOMINANT FACTOR IN DORMANCY OF CANCER BUSH (SUTHERLANDIA FRUTESCENS) - Mkhwanazi, Ubisi, Kgotse, Mlombo, Timana, Dube, Letsoalo	H1	EVALUATION OF DNA MOLECULAR MARKERS FOR FINGERPRINTING SELECTED LITCHI CULTIVARS - Hajari, Nonyane, Cronje	H7	PROTEOMICS ANALYSIS OF HONEYBUSH (CYCLOPIA SUBTERNATA) LEAVES IN RESPONSE TO DROUGHT STRESS - Mabizela, Mathabe, Slabbert, Van der Rijst, Bester	H12	EFFECT OF HARVESTING TIME ON YIELD AND QUALITY OF ROSEMARY, ROSE GERANIUM AND THYME ESSENTIAL OILS - Du Preez, De Jager	H26	DOES ELEVATED CO2 AFFECT THE BIOCHEMICAL QUALITY AND NUTRITIONAL PARAMETERS OF SWEETCORN (ZEA MAYS L. VAR. SACCHARATA) - Bertling, Dlulisa
H34	EFFECT OF LOW AND HIGH MOLECULAR WEIGHT CHITOSAN ON THE EXPRESSION OF DEFENSE-RELATED GENES OF AVOCADO PERICARP - Mokgalapa, Pillai, Akinola, Sivakumar	H2	SWEET BASIL RESPONSE TO VARYING NUTRIENT SOLUTION CONCENTRATIONS AND WATER FLOW RATES IN A GRAVEL FILM RECIRCULATING HYDROPONIC SYSTEM - Moremi, Steyn, Ibraimo	H8	TO PROTECTED ENVIRONMENT OR NOT: REVEALING CONVINCING EVIDENCE OF UV-INDUCED GEOMETRICAL ISOMERIZATION OF CINNAMIC ACID CONTAINING MOLECULES IN BUSH TEA (ATHRIXIA PHYLLICOIDES DC.) USING UHPLC-QTOF-MS - Ramphinwa, Madala, Mudau, Mchau	H13	THE EFFECT OF VARYING LIGHT INTENSITY ON MORPHOLOGICAL AND QUALITY PARAMETERS OF SWEET PEPPERS - Dlamini, Bertling	H27	EXOGENOUS ETHEPHON APPLICATION AFFECTS GENE EXPRESSION OF ETHYLENE-, DORMANCY- AND FLOWERING-RELATED GENES AND ALTERS TREE PHENOLOGY AND PHYSIOLOGY IN LITCHI, CV. "MAURITIUS" - Cronje, Hajari, Ratlapane, Hoffman, Jonker
H35	RESPONSE OF CHILI PEPPER CULTIVARS (CAPSICUM FRUTESCENS L.) TO NITROGEN FERTILIZER AND PLANTING DENSITY - Maphoto, Bertling, Maboko, Ibraimo	H3	EFFECT OF NITROGEN FERTILIZER SOURCE ON GROWTH, YIELD, QUALITY, AGRONOMIC PERFORMANCE, AND NITROGEN USE EFFICIENCY OF SHORT-DAY ONION IN RESPONSE TO THE COMBINED APPLICATION OF DIFFERENT NITROGEN FERTILIZERS - Simelane, Soundy, Maboko	H9	ESTABLISHMENT OF HONEYBUSH CUTTINGS AND SEEDLINGS IN THE FIELD AND THE EFFECT OF BIOSTIMULANTS ON REDUCING ABIOTIC STRESS WHEN TRANSPLANTING ROOTED CUTTINGS - Karsen, Hoffman, Lötze, Valentine	H14	EARLY ASSESSMENT OF COMPATIBILITY IN SELECTED LITCHI SCION-ROOTSTOCK COMBINATIONS - Hannweg, Maphanga, Shezi, Penter, Hajari	H28	THE IMPACT OF ELEVATED CO2 ON GROWTH, DEVELOPMENT, AND REPRODUCTION ON SWEETCORN (ZEA MAYS L. VAR. SACCHARATA) - Dlulisa, Bertling, Cluclow
H36	INFLUENCE OF FOLIAR APPLIED ZINC CARRIERS ON PECAN NUT [CARYA ILLINOENSIS L. (WANGENH.) C. KOCH] - Visser, Schmidt, Coetzer	H4	RECOVERY RESPONSE OF SIMULATED HAIL-DAMAGED ROSE GERANIUM (PELARGONIUM GRAVEOLENS L'Hér "Bourbon") TO DIFFERENT MIXTURES OF AGRICULTURAL PLANT GROWTH REGULATORS - Khetsha, Sedibe, Pretorius, Van Der Watt	H10	THE EFFECT OF PRUNING AND HARVESTING ON VEGETATIVE GROWTH AND FLOWERING OF LEUCOSIDEA SERICEA - Mabusela, Matsiliza-Mlathi, Kleynhans, Araya	H15	THE EFFECT OF PROHEXADIONE-CALCIUM APPLICATION ON SHOOT REGROWTH, CROP LOAD AND FRUIT YIELD ALTERNATION IN FUJI APPLE TREES - Horne, Kotze, Krige, Steyn, Theron, Siboza	H29	SELECTION OF STABLE AND HIGH-YIELDING DWARFING APPLE ROOTSTOCK GENOTYPES - Ngindi, Siboza, Theron, Steyn
H37	STORAGE OF RADISH MICROGREENS UNDER DIFFERENT LED LIGHTS IMPACTS RADISH QUALITY AND ANTIOXIDANT PROPERTY - Ntsoane, Maboko, Manhivi, Sivakumar	H5	EFFICACY OF LACTIC ACID BACTERIA STRAINS ON ANTHRACNOSE DECAY AND FRUIT QUALITY OF AVOCADO (PERSEA AMERICANA) FRUIT (FUERTE) - Mpeluza, Sivakumar, Akinola	H11	EFFICIENCY OF RHIZOBIA STRAINS ON GROWTH, SELECTED MACRONUTRIENTS AND PROTEIN CONTENT OF CANCER BUSH (SUTHERLANDIA FRUTESCENS) - Masenya, Pofu, Mashela	H16	PHENOLOGY AND PRODUCTION OF HELICHRYSUM ODORATISSIMUM - Makena, Matsiliza-Mlathi, Kleynhans	H30	GENETIC DIVERSITY AND PHYLOGENETIC ANALYSIS OF RHIZOBIAL SYMBIONTS OF GROUNDNUT, JACK BEAN AND SOYBEAN SOURCED FROM DIFFERENT LOCATIONS IN ESWATINI - Ngwenya, Dakora, Mohammed
H38	CHARACTERISTICS OF THE SWEET POTATO THAT INDICATE ITS POTENTIAL TO ADDRESS ISSUES OF FOOD AND NUTRITION SECURITY IN THE CONTEXT OF CHANGING GLOBAL CLIMATE - Shange, Phosa	H6	GENETIC DIFFERENCES BETWEEN AVOCADO SUNBLITCH VIROID (ASBVD) VARIANTS DETECTED IN A CLONAL POPULATION OF YOUNG, SYMPTOMLESS "FUERTE" TREES - Zwane, Gubba, Jooste			H17	GROWTH, HERBAGE AND OIL YIELD OF SELECTED HIGH-VALUE ESSENTIAL OIL CROPS AS INFLUENCED BY VARIOUS AGRONOMIC FACTORS - Malaka, Araya, Soundy, Jansen van Rensburg, Du Plooy, Araya, Watkinson, Amoo	H31	CHITOSAN HYDROCHLORIDE COATINGS LOADED WITH FUNCTIONAL COMPOUNDS PROTECT AVOCADO FRUIT ("FUERTE") FROM ANTHRACNOSE AND ACTIVATE THEIR DEFENSE MECHANISMS - Osondu, Akinola, Shoko, Pillai, Sivakumar
						H18	ROOFTOP RAINWATER HARVESTING FOR SUPPLEMENTAL IRRIGATION OF SWISS CHARD (BETA VULGARIS VAR. CICLA) CULTIVATED IN A BAG CULTURE SYSTEM - Maleka, Araya, Soundy	H32	FATTY ACID PROFILES IN SOUTH AFRICAN MACADAMIAS AND THEIR IMPACT ON QUALITY AND SHELF LIFE - Penter
						H19	EFFECT OF PLANTING DENSITY ON GROWTH AND YIELD OF FIELD AND HYDROPONICALLY GROWN CHILI PEPPER (CAPSICUM FRUTESCENS L.) - Maphoto, Bertling, Maboko, Ibraimo		
						H20	ESTABLISHING PROPAGATION TECHNOLOGY FOR BUDDLEJA SALIGNA AND EUCLEA NATALENSIS - Maringa, Kleynhans, Prinsloo		
						H21	THE EFFECT OF TIMING OF APPLICATION AND DOSAGE OF CLOPROP ON FRUIT ENLARGEMENT AND CLOPROP RESIDUES IN QUEEN PINEAPPLE FRUIT AT HARVEST - Mbatha, Rabie		
						H22	MODELLING AND MAPPING FUTURE CLIMATIC CONDITIONS FOR POME AND STONE FRUIT PRODUCTION IN THE WESTERN CAPE OF SOUTH AFRICA - Midgley, Schulze, Davis		
						H23	THE EFFECT OF DIFFERENT PRE-TREATMENTS TO BREAK SEED DORMANCY OF HYPOXIS HEMEROCAL-LIDEA - Mtshweni, Kleynhans, Matsiliza-Mlathi		
						H24	EVALUATING THE EFFICACY OF MORINGA OLEIFERA LEAF EXTRACTS PREPARED USING DIFFERENT SOLVENTS ON GROWTH, YIELD AND QUALITY OF TOMATOES AND PEPPERS - Ngcobo, Bertling		
						H25	THE CONTROL OF NATURAL FLOWERING IN QUEEN PINEAPPLE WITH TREATMENT COMBINATIONS OF AVIGLYCINE, CLOPROP, RHAMNOLIPIDS AND FERTILISERS DURING WINTER MONTHS IN SOUTH AFRICA - Rabie, Mbatha		



POSTERS			SSSSA ORAL PRESENTATIONS				
	SSSSA poster session		Session 1		Session 2		Session 3
			Soil Classification & Mapping		Soil Biology & Fertility		Soil Physics & Technology
Number		Number	Title	Number	Title	Number	Title
		S1	REFINING DIGITAL SOIL MAPPING PROTOCOLS TO IMPROVE SOIL ECOTOPE MAPPING IN THE KWAZULU-NATAL BIORESOURCE CLASSIFICATION SYSTEM - Atkinson, De Clercq, Rozanov	S8	CARBON LOSSES AND GAINS IN AGRICULTURAL SOILS: A BASELINE STUDY OF THE MICROBIAL COMMUNITY OF TWO SOILS UNDER TWO CULTIVATION PRACTICES - Kidson, Rama, Adeleke, Paterson, Roopnarain	S17	SOIL HEALTH AND CROP DIVERSIFICATION IN SUB-SAHARAN AFRICA: COMBINING EXPERT KNOWLEDGE WITH INTEGRATED MODELLING FOR BUILDING RESILIENT FOOD SYSTEMS - Eze, Zimba, Dougill, Challinor, Pope, Clark, Coskeran, Mashingaidze, Macdiarmid, Fitton, Smith, King, Chapman, Mwamakamba, Kepinski, Jennings, Vetter, Tim Benton, Madzivhandila
S23	SOIL ENZYME ACTIVITIES AND SOIL ALTERATION INDEX RESPONSE TO BIOSTIMULANT APPLICATION IN A TABLE GRAPE VINEYARD - Mahlare, Meyer, Mfeka, Van Huyssteen, Rhode	S2	INVESTIGATION INTO THE ACCURACY OF SELECTED SOIL PROPERTIES FOR DIFFERENT GLOBAL AND REGIONAL SOIL MAPS RELEVANT TO SOUTHERN AFRICA - Bodenstein, Clarke, Watson, Miller, Van der Westhuizen, Rosanov	S9	MINE REHABILITATION ASSESSMENT USING AN ENZYME-BASED SOIL ALTERATION INDEX - Meyer, Rhode, Van Huyssteen	S18	EFFECT OF SOIL FORMS ON SOIL WATER AND DRYLAND COTTON PRODUCTION - Gagiano, Van Zijl, Dreyer, Daniell
S24	SOIL ENZYME ACTIVITIES AND SOIL ALTERATION INDEX RESPONSE TO BIOSTIMULANT APPLICATION IN A WINE GRAPE VINEYARD - Mahlare, Meyer, Mfeka, Van Huyssteen, Rhode	S3	IS SOIL A DRIVING FACTOR OF BUSH ENCROACHMENT IN THE NORTH WEST PROVINCE? - Cloete	S10	FIRE AND HERBIVORE GRAZING ALTERS SOIL CARBON AND NUTRIENTS IN A SAVANNA GRASSLAND - Ramabopa, Dlamini, Archibald	S19	MID-INFRARED SPECTROSCOPY CALIBRATION MODELS FOR SOIL PROPERTY PREDICTION WITHIN THE WESTERN HIGHVELD - Kock, Van Zijl, Ramphisa
S25	AN ENZYME-BASED SOIL ALTERATION INDEX (AI3) FOR MINE REHABILITATION ASSESSMENT - Meyer, Van Huyssteen, Rhode	S4	DIGITAL SOIL MAPPING OF THE JUKSKEI RIVER CATCHMENT USING A MACHINE LEARNING APPROACH - Coetzee, Van Zijl	S11	SOIL ORGANIC CARBON AND MICROBIAL ACTIVITY IN HUMIC SOILS UNDER GREEN CANE RELATIVE TO PRE-HARVEST BURNING - Mkhonza, Muchaonyerwa	S20	CHARACTERIZATION OF PINWOOD BIOCHAR AND ITS POTENTIAL USE IN REDUCTION OF HEAVY METAL CONTAMINATES MIGRATION - Mamera, Van Tol, Aghoghovwia
S26	BIOREMEDIATION OF HEAVY METALS IN AGRICULTURAL SOILS IRRIGATED WITH TREATED WASTEWATER - Phadu, Kgopa	S5	ASSESSING SOIL SURFACE SALT ACCUMULATION (SOIL SALINITY) USING MULTISPECTRAL IMAGES IN SYFERKUIL FARM - Mamorobela	S12	THE RESPONSE OF SOIL PHYSICOCHEMICAL PROPERTIES TO RAINFED AND IRRIGATED MAIZE/LEGUME INTERCROPPING SYSTEMS - Nong, Pholoshu, Ogola	S21	BUILDING CLIMATE-SMART, NUTRITION-SECURE PATHWAYS IN AFRICA USING IFEEED - AN INTEGRATED FUTURE ESTIMATOR FOR EMISSIONS AND DIETS FRAMEWORK - Vetter, Challinor, Pope, Clark, Coskeran, Mashingaidze, Macdiarmid, Fitton, Smith, King, Chapman, Mwamakamba, Jennings, Walker, Benton, Madzivhandila
S27	EFFECTS OF PHYTOREMEDIATION ON SELECTED CHEMICAL PROPERTIES OF SOILS IRRIGATED WITH TREATED WASTEWATER - Malatji, Kgopa, Bopape-Mabapa	S6	THE DEVELOPMENT OF THE NWU SOIL DATABASE AS A PRECURSOR FOR A NATIONAL SOIL DATABASE - Sehlapelo, Ramphisa, Van Zijl	S13	CROPPING SEQUENCES INFLUENCE ON LABILE CARBON AND PHOSPHORUS FRACTIONS IN A CONSERVATION AGRICULTURE SYSTEM - Sosibo, Muchaonyerwa, Dube, Tsilo		
S28	PLANT WATER-USE EFFICIENCY AND SYMBIOTIC N NUTRITION OF 15 SOYBEAN (GLYCINE MAX) GENOTYPES GROWN IN THE UPPER WEST REGION OF GHANA, USING 13C AND 15N NATURAL ABUNDANCE TECHNIQUE - Mnguni, Mohammad, Mahama, Abdulai, Dakora	S7	SOIL MAPPING FOR HYDROPEDOLOGICAL ASSESSMENTS - Van Zijl	S14	PRELIMINARY FINDINGS OF A QUANTITATIVE REVIEW OF SUGARCANE RESPONSES TO SILICON-RICH AMENDMENTS UNDER FIELD CONDITIONS - Titshall		
S29	PRELIMINARY RESULTS ON THE EFFICACY OF POLYACRYLAMIDE (PAM) TO ALLEVIATE SOIL CRUSTING FOR RECLAMATION OF DEGRADED LAND IN DINOKENG GAME RESERVE - Human, Nortjè, Laker			S15	SOIL ORGANIC CARBON STRATIFICATION UNDER CONSERVATION AGRICULTURE IN THE WESTERN CAPE PROVINCE - Van der Merwe, Labuschagne, Hardie-Pieters		
S30	THE VARIATION IN SOIL CARBON EMISSION RATES IN FIVE LAND USE SYSTEMS OF THE LETABA CATCHMENT, LIMPOPO PROVINCE, SOUTH AFRICA - Ntuli, Monjonji, Dlamini, Ayisi			S16	CONCENTRATIONS AND FRACTIONS OF ORGANIC CARBON AND PHOSPHORUS AS AFFECTED BY PIG SLURRY APPLICATION ON OXIDIC SOILS UNDER SUBHUMID CONDITIONS - Zwane, Muchaonyerwa		
S31	APPLICATION OF BIO-SLURRY TO IMPROVE MAIZE PRODUCTION IN RURAL COMMUNITIES - Anderson, Wessels, Koatla						
S32	USE OF DEMONSTRATION PLOTS AS AN EFFECTIVE TECHNOLOGY TRANSFER TOOL TO EMPOWER RURAL COMMUNITIES - Wessels						



POSTERS						SASCP ORAL PRESENTATIONS					
	SASCP Poster Session 1		SASCP Poster Session 2		Session 1		Session 2		Session 3		Session 4
					Agrometeorology, Adaptation, Breeding & Crop Modelling		Conservation Agriculture, Crop Protection, Weeds & Herbicides		Crop Nutrition & Water		Crop Physiology & Production
Num-ber		Number		Number	Title	Number	Title	Number	Title	Number	Title
C37	CALIBRATION AND VALIDATION OF THE DSSAT MODEL FOR DRY BEAN (PHASEOLUS VULGARIS) GROWTH - Mathobo	C53	THE EFFECT OF PLANT GROWTH PROMOTING RHIZOBACTERIA ON WHEAT GROWTH UNDER A CONTROLLED PHOSPHATE REGIME - Breedt, Gokul, Korsten, Labuschagne	C1	MODELLING CLIMATE CHANGE IMPACT ON DRYLAND WHEAT PRODUCTION IN SOUTH AFRICA USING GCM PROJECTIONS AND DSSAT MODEL: FREE STATE - Ajilogba, Walker	C9	DYNAMICS OF DIVERSIFI-CATION THROUGH CROP ROTATIONS - Louw, Strauss, Swanepoel, Van der Westhuizen	C20	EFFECT OF NITROGEN FERTILIZER AND SOIL MOISTURE LEVELS ON THE PERFORMANCE OF DROUGHT TOLERANT MAIZE ON FERRIC LUVISOL AND RHODIC FERRALSOL SOILS - Adebayo, Sebetha, Kutu	C27	NODULATION OF COMMON BEAN (PHASEOLUS VULGARIS L.) BY BACTERIAL SYMBIONTS ENDEMIC TO THE CAPE FYNBOS BIOME OF SOUTH AFRICA - Mpai, Jaiswal, Dakora
C38	CONCENTRATION DEPENDANT RESPONSE OF PHASEOLUS VULGARIS GERMINATION TO MEXICAN PRICKLY POPPY - Mlombo, Dube, Nxumalo, Ganyani, Mnyambo, Timana	C54	PHAKOSPORO PACHYYIRHIZI A KEY PEST IN SOYBEAN DISEASE COMPLEX - Dube, Shabalala, Ganyani	C2	ASSESSING THE POTENTIAL IMPACTS OF CLIMATE CHANGE IN BARLEY (HORDEUM VULGARE L.) GROWING AREAS IN SOUTH AFRICA - Madimabe, Van der Laan, Walker	C10	MORE THAN A DECADE OF MONOCULTURE VS CROP ROTATION IN SWARTLAND WHEAT FIELDS - WHAT HAPPENED IN THE SOIL? - Marais, Booyse, Botha	C21	NITROGEN FERTILISATION OF CANOLA (BRASSICA NAPUS L.) PRODUCED IN CONSERVATION AGRICULTURE SYSTEMS IN THE WESTERN CAPE, SOUTH AFRICA - Crous, Labuschagne, Swanepoel	C28	POTATO (SOLANUM TUBEROSUM L.) RESPONSE TO ELEVATED CARBON DIOXIDE AND TEMPERATURE - Steyn, Kiongo, Taylor, Franke
C39	ARGEMONE OCHROLEUCA SUPPRESSION OF MAIZE AND PEARL MILLET GERMINATION IS PLANT-PART DEPENDENT - Nxumalo, Ganyani, Timana, Mnyambo, Mlombo, Dube	C55	DRYBEAN YIELD UNDER THE INFLUENCE OF CULTIVAR, PHOSPHORUS FERTILIZER RATE AND LOCATION - Islam, Sebetha	C3	INVESTIGATING THE ECOLOGICAL INTENSIFICATION OF WHEAT (TRITICUM AESTIVUM L.) PRODUCTION USING LONG-TERM TRIAL DATA AND MODELLING - Magwaza, Van der Laan, Marais	C11	WHEAT PERFORMANCE AND QUALITY FOLLOWING DIFFERENT COVER CROP MIXTURES AND MANAGEMENT REGIMES - Smit, Strauss	C22	NITROGEN SOURCE EFFECTS ON CANOLA (BRASSICA NAPUS L.) GROWN UNDER CONSERVATION AGRICULTURE IN THE WESTERN CAPE, SOUTH AFRICA - Crous, Labuschagne, Swanepoel	C29	EFFECT OF FUNGICIDE APPLICATION ON POTATO CULTIVARS AT CEDARA - Arathoon
C40	THE QUANTITY OF NITROGEN AVAILABLE IN THE SOIL FOLLOWING LEGUME CROPS - Augustyn, Lombard, Strauss, Swanepoel	C56	FARMING UP THE CITY: ADDRESSING HIDDEN HUNGER THROUGH VEGETABLES - Khoza, Marais	C4	NOWCASTING DAILY MINIMUM CANOPY AND AIR TEMPERATURES FOR FROST: POSSIBLE? - Savage	C12	INTEGRATING LIVESTOCK AND CASH CROPS UNDER CONSERVATION AGRICULTURE: SHEEP BREED PERFORMANCE AND CORRELATION WITH WHEAT PRODUCTION - Smit, Strauss, Laubscher	C23	RESPONSE OF CANOLA (BRASSICA NAPUS L.) VARIETIES TO DIFFERENT LEVELS OF NITROGEN FERTILISER - Lombard, Strauss, Smorenburg	C30	RELATIONSHIPS BETWEEN YIELD AND YIELD COMPONENT TRAITS OF DROUGHT-TOLERANT MAIZE VARIETIES EXPOSED TO HEAT STRESS AND COMBINED HEAT AND WATER STRESS CONDITIONS - Chukwudi, Mavengahama, Kutu
C41	THE POTENTIAL OF MIXED COVER CROPS AS DRYLAND FODDER OR PASTURE - Engelbrecht, Strauss, Dube	C57	EFFECT OF CHICKEN MANURE AND MYCORRHIZAE INOCULANT ON THE ESTABLISHMENT, GROWTH DEVELOPMENT OF ROOIBOS PLANTS - Marais, Lotze, Botha, Van der Rijst	C5	CLIMATE-SMART AGRICULTURE (CSA) TRAINING FOR EXTENSION PRACTITIONERS IN THREE PROVINCES - Walker, Anderson, Maboa, Masekwana, Ngotho	C13	EFFECT OF CROP SEQUENCE ON SELECTED SOIL, YIELD AND ECONOMIC PARAMETERS - Strauss, Smit, Laubscher	C24	LEAF SCORCHING DUE TO FOLIAR APPLICATION OF SYNTHETIC ACID MINE DRAINAGE AND THE EFFECTIVENESS OF AN ANTI-TRANSPIRANT IN PROTECTING LEAVES - Mabuza, Annandale, Steyn, Tanner	C31	THE EFFECT OF PLANT DENSITY, ZINC ADDED TO PHOSPHORUS FERTILISER SOURCES AND LOCATION ON YIELD PERFORMANCE OF SOYBEAN - Gonyane, Sebetha
C42	SOIL CARBON SEQUESTRA-TION UNDER DIFFERENT CROP ROTATION SYSTEMS IN THE SWARTLAND REGION - Matthews, Swanepoel, Strauss	C58	GEOGRAPHIC DISTRIBUTION OF COLLECTED SORGHUM (SORGHUM BICOLOR (L.) MOENCH) AND MAIZE (ZEA MAYS L.) LANDRACES IN SOUTH AFRICA - Matelele	C6	ASSESSING THE IMPACT OF SILICON FERTILIZERS ON YIELD AND AGRONOMIC TRAIT ASSOCIATIONS IN WHEAT UNDER DROUGHT AND NON-STRESSED CONDITIONS - Christian, Shimelis, Laing, Tsilo	C14	CONSERVATION FARMING PRACTICES FOR POTATO PRO-DUCTION IN THE SANDVELD REGION OF SOUTH AFRICA - A FOUR YEAR STUDY - Van Zyl, Van Zyl	C25	THE TIMING OF NITROGEN FERTILIZER APPLICATION AND CULTIVAR ON MAIZE GROWTH PERFORMANCE UNDER DIFFERENT ENVIRONMENTAL CONDITIONS - Mashele, Sebetha	C32	MAIZE YIELD RESPONSES TO VARYING INPUT APPLICATION IN ON-FARM PRECISION EXPERIMENTATION - Maseko, Van der Laan, Meyer, Delport, Otterman, Edge, Tesfamariam
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Second Week of Combined Congress 2022

LIVE SESSIONS			
	25 January 2022	26 January 2022	27 January 2022
09:00 – 10:15	SASHS – Keynote PROF WIEHANN STEYN – ACADEMIA AND INDUSTRY PARTNERING INTO THE FUTURE	SSSSA – Keynote PROF DONALD SPARKS – THE WATER, CLIMATE, SOIL AND FOOD NEXUS: GRAND CHALLENGES IN A CHANGING ENVIRONMENT	SASCP – Keynote DR CHLOE MACLAREN – THE PAST, PRESENT AND FUTURE OF LONG-TERM AGRICULTURAL EXPERIMENTS
10:30 – 11:30	SASHS – Q&A Session 1	SSSSA – Q&A Session 2	SASCP – Q&A Session 3
	Biotechnology, Breeding, Propagation, Nutrition, Water Mangement & Crop Protection (and all posters)	Soil Biology & Fertility (orals & posters)	Crop Physiology, Production, Nutrition & Water
12:00 – 13:00	SSSSA – Q&A Session 1	SASCP – Q&A Session 2	SASHS – Q&A Session 3
	Soil Classification & Mapping (orals & posters)	Conservation Agriculture, Crop Protection, Weeds & Herbicides	Indigenous, Medicinal Plants; New & Alternative Crops; Physiology & Post-Harvest Biology
13:30 – 14:30	SASCP – Q&A Session 1	SASHS – Q&A Session 2	SSSSA – Q&A Session 3
	Agrometeorology, Adaptation, Breeding & Crop Modelling	Production & Cultivation Practices	Soil Physics & Technology (orals & posters)
15:00 – 16:30	AGM – SASHS	AGM – SSSSA	AGM – SASCP

PLEASE TAKE NOTE

All oral presentations (videos) will be available for viewing
in Crowdcast – please check your e-mail for the links.

Questions about video presentations: Click on Ask a Question in
Crowdcast to post your question/comment about a specific presentation.

All poster presentations (PDF's) will be available for viewing in
PDF booklets – please check your e-mail for the attachments.

Questions about posters: Please e-mail your questions for
the Q&A sessions to Dr Johann Strauss at JohannSt@elsenburg.com.
Please indicate the poster number and session.

Deadline for submitting of questions: Saturday 22 January 2022 @ 11:00

Enquiries: events@landbou.com



COMBINED CONGRESS

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ABSTRACT – KEYNOTE SPEAKER
SASHS – Prof W. Steyn

ACADEMIA AND INDUSTRY PARTNERING INTO THE FUTURE
Prof W. Steyn
University of Pretoria

Saying that change is the only constant/the new normal, has become somewhat clichéd. Nevertheless, everybody involved in the fruit industry over the last two seasons would wholeheartedly agree and would in fact insist that the speed of change is ever increasing. On top of the accelerating rate of change, people in the fruit industry also have to contend with “black swan” events and “predictable surprises” in an extremely interconnected, “VUCA” world. In such a world, competition in the marketplace is becoming fiercer by the year and only the fittest fruit industries will survive.

What will it take for the South African deciduous fruit industry to survive or, preferably, flourish in an increasingly competitive world? There are various global or macro factors beyond our control. We cannot influence the impact of the exchange rate and the cost of agrochemicals on profitability, nor can we change the climate. Fortunately, we can soften the impact of some factors like climate change, decreasing water availability, market restrictions on phytosanitary pests and the financial cost squeeze through good strategies and good implementation thereof. In terms of the production, storage and marketing of our fruit, we really need to be on top of our game.

In the end, our success as industry, given some of the constraints beyond our control, comes down to the expertise/quality of people we have in place at different levels of our industry. It is in terms of ensuring that industry has access to the right human capacity where universities and research institutions can make their biggest

contribution to the competitiveness and future success of an industry. Our highly technical industry is dependent on a steady supply of well-trained graduates who are up to speed with the latest technology and future directions of fruit production to ensure that our product is of a high quality, safe, sustainable and preferred by consumers. We also need access to “knowledge resources”, experienced researchers and academics, who can provide direction to industry, lead change and trouble shoot sticky issues. These knowledge resources are becoming increasingly scarce in applied fields like horticultural science where too few academically strong people pursue a PhD and an academic or research career. It is a major concern when the educators with a good industry understanding, and profile are lost because over time this will erode the technical capacity of industry. Of course, academia and research institutions also play a very important role in solving industry problems. However, the very practical research that is often required by a solution-focused industry, is not always compatible with publication, which remains a key currency at academic level.

My presentation will touch on the collaboration between industry and academia, in terms of the benefits, some of the challenges as well as the different models of collaboration. I will aim to describe how these relationships might look in future, although perfect foresight is of course not possible. Due to my background, I will primarily focus on deciduous fruit and Stellenbosch University with whom our industry has had a long standing and mutually beneficial partnership.

ABSTRACT – KEYNOTE SPEAKER
SSSSA – Prof D. Sparks

**THE WATER, CLIMATE, SOIL AND FOOD NEXUS:
GRAND CHALLENGES IN A CHANGING ENVIRONMENT**
Donald L. Sparks

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Chair in Soil and Environmental Chemistry
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Land degradation, water quality and quantity, air quality, climate change, soil contamination, and food security are foremost issues of our time. We must be at the forefront in addressing and providing solutions to these vexing challenges that threaten humankind. It is also incumbent

that we tackle the research needs in an interdisciplinary manner by forging collaborations with natural scientists, social scientists, engineers, and humanists. We must also communicate the results and solutions in a meaningful way to decision makers and the public. This presentation will focus on the impacts of a changing climate on coastal resiliency, soil and water contamination, cycling of nutrients, food production, and national security. Opportunities will be presented on how to address some of these complex challenges.

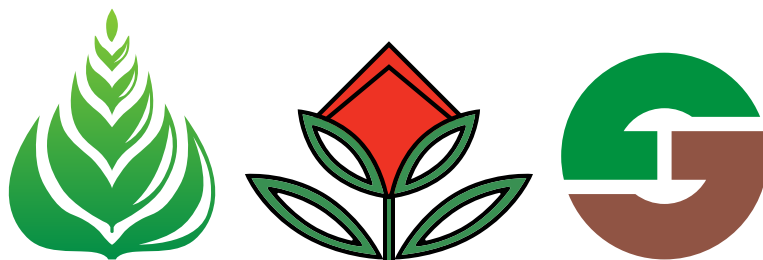
ABSTRACT – KEYNOTE SPEAKER
SASCP – Dr C. MacLaren

**THE PAST, PRESENT AND FUTURE OF
LONG-TERM AGRICULTURAL EXPERIMENTS**
Dr C. MacLaren
Cropping Systems Ecologist, Rothamsted Research

Long-term experiments (LTEs) provide unique insights into the functioning and performance of agricultural systems over long timescales. The lifespan of LTEs often stretches far into the past (the world’s oldest LTE, Broadbalk at Rothamsted Research in the UK, began nearly 180 years ago) but the knowledge gained from LTEs is key to our future. Unlike shorter-term experiments, LTEs can identify whether agricultural systems sustain their productivity over long timescales, and whether systems are resilient to temporal shocks and stresses such as climate change and market fluctuations.

Over the past few decades, LTEs have charted dramatic yield increases resulting from the advance of agricultural technology but have also highlighted the pitfalls of relying too much on technology alone. Simple intensive systems tend

to have fewer stable yields than more diverse systems, and their productivity over time can become limited by weeds and soil degradation. Today, some LTEs are being modified and new ones designed to incorporate this understanding of the need for diversity into new treatments, but there is still much to learn from existing LTEs. Researchers are finding increasingly innovative ways to ask new questions of old experiments: there are new theories to be tested against established trends, new statistical methods to enable more complex analyses, and new collaborations between multiple LTEs to answer questions that cannot be addressed by any LTE alone. Despite their often-venerable age, LTEs are far from being stale relics of the past – they are living, dynamic systems that continue to make important contributions to our understanding of sustainable and resilient agriculture.



COMBINED CONGRESS

Annual congress of
SSSSA, SASHS & SASCP

Abstracts

Oral presentations:
Horticultural Science
(SASHS)

Presenter: Dr Isa Bertling (bertlingi@ukzn.ac.za)

Author(s)

#	Name	Affiliation
1	Dr Isa Bertling	UKZN

Introduction:

Consumer awareness of vegetable quality has led to researchers investigating the effect of environmental conditions on certain quality parameters of vegetables. One particular environmental factor is the increasing atmospheric CO₂, affecting growth and productivity of vegetable crops. The study aimed to investigate, whether elevated CO₂ would have a positive effect on biochemical quality parameters of sweetcorn.

Materials and Methods

Maize plants (STAR7719) were established in two adjacent glasshouses, one being ambient CO₂ (aCO₂, ~430 ppm) and the other maintained elevated CO₂ (eCO₂, ~500 ppm) through the use of “Because Nature Mycelium CO₂ generator bags” (Windell Hydroponics.co.za, Cape Town, SA). Fresh cobs were harvested and analysed for ascorbic acid, carotenoids, total protein, total soluble solids (TSS) and minerals in three locations of the cobs.

Results and Discussion

Significant differences were found between eCO₂ and aCO₂ in kernel ascorbic acid and TSS; however, there was only a tendency to increased protein and carotenoid concentrations in the eCO₂ cobs. There were also no significant differences in mineral concentration analysed in sweetcorn kernels for different cob locations, however, eCO₂ tended to affect cob mineral concentration.

Conclusion

In conclusion, eCO₂ concentrations of approximately 500 ppm have positive and negative effects on sweetcorn quality. Similar to the presented results, mineral nutrients and protein were reported not to be affected by eCO₂ treatment (Von Caemmerer and Furbank, 2003, Parcell, 2002), while carotenoids were decreased under eCO₂. Further research on the potentially positive effects of eCO₂ on nutritional quality of crops is, therefore, encouraged.

References

Parcell S. (2002). Sulfur in human nutrition and applications in medicine. *Altern. Med. Rev.* 7, 22–44.

Von Caemmerer, S., and Furbank, R. T. (2003). The C(4) pathway: an efficient CO₂ pump. *Photosynth. Res.* 77, 191–207. doi: 10.1023/A:1025830019591

Keywords:

Ambient CO₂; elevated CO₂; Mineral nutrition; Mycelium CO₂ bags; phytochemical parameters; sweetcorn

Presenter: Mrs Regina Cronje (regina@arc.agric.za)

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4	Mr Arnold Jonker	Faculty of Science and Agriculture, University of Limpopo, Private Bag X1106, Sovenga 0727
5	Dr Lynn Hoffman	Department of Horticultural Science, University of Stellenbosch, Private Bag X1, Matieland 7602

Introduction:

In litchi cultivation, ethephon applications are used during autumn and early winter to prevent new vegetative shoot growth, which otherwise would inhibit flowering because litchi can only bear flowers on fully mature shoots. However, little is known about the mode of action of ethylene, the breakdown product of ethephon, in the leaves and buds of litchi and its association with litchi flowering. Therefore, the effect of exogenous applied ethephon on ethylene evolution, gene expression, carbohydrate and phenological changes was studied and its association with litchi flowering investigated.

Materials and Methods

Ethephon was applied as a single full canopy spray at a concentration of 1000 mg L⁻¹ to fully hardened trees with dormant terminal buds during April 2018. Untreated trees served as a control. Ethylene evolution and expression levels of ethylene- (LcEIN3), dormancy- (LcSVP2) and flowering- (LcFT2, LcFLC, and LcAP1) related genes were measured in leaves and apical buds of 'Mauritius' litchi at various bud stages using gas chromatography and quantitative PCR analysis, respectively. In addition, shoot maturity and carbohydrate concentrations in leaves and terminal shoots were determined using a chlorophyll meter and HPLC analysis, respectively.

Results and Discussion

In both leaves and buds, ethylene evolution increased sharply on the day of application, but declined rapidly thereafter in the leaves, while it remained high in apical buds for seven days after application before slowly declining thereafter. Only negligible ethylene evolution was detected in untreated trees. Expression levels of LcEIN3, LcFLC and LcSVP2 were significantly upregulated in buds one day after ethephon application. This directly corresponded with the high ethylene evolution rates in buds and explained the reduced flushing incidence, enhanced shoot maturity, increased sucrose concentrations, extended bud dormancy and delayed flower panicle emergence in treated trees. Significantly higher expression levels of the flower promoting genes LcFT2 and LcAP1 at bud break indicated successful flower induction in ethephon treated trees under lower inductive temperatures, compared with untreated trees.

Conclusion

An association between ethephon treatment, shoot maturity, leaf sucrose content and gene expression of flower suppressing and promoting genes at specific phenological stages could be established and confirmed their important role in enhancing litchi flowering.

Keywords:

ethylene evolution, bud dormancy, flushing, flowering, relative gene expression, leaf sucrose

Presenter: Siyabonga Welcome Dlamini (syabongawn@gmail.com)

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Introduction:

Sweet pepper is a Solanaceous, highly nutritious fruit vegetable crop, it is a tropical perennial, cultivated worldwide in tropical, subtropical and even temperate regions of the world (Samuels 2015). The importance of this crop results from its phytochemical content since it is rich in ascorbic acid and several carotenoids. The phytonutrients in pepper fruit are highly important to human health; ascorbic acid boost the immune system, acts as a strong antioxidant, prevents several diseases, amongst others cancer, cataracts, and heart diseases (Ramya 2019). As exposing tomato plants to additional light has been demonstrated to enhance phytonutrient concentrations (Ngcobo et al., 2020), an experiment was conducted to enhance sweet pepper nutritional and physiological quality parameters by directing additional light onto the plant through reflective foil placed between the rows in the tunnel experiment.

Materials and Methods

Pepper plants were either exposed to additional light through reflective aluminium foil placed at the floor of the tunnel or no additional radiation was provided. Treatments were replicated three times and plants arranged in a complete randomised design (CRD). Vegetative growth parameters of sweet peppers were recorded for treatment and control plants. Further, the chlorophyll and carotenoid concentration of pepper fruit was investigated (Lichtenthaler, 1987). Results were analyzed using Genstat version 18.

Results and Discussion

There were no significant differences in morphological characteristics, time to flowering and fruit mass between the two groups. Significant differences were, however, observed in total chlorophyll concentrations, with aluminium-foil-treated sweet peppers containing less total chlorophyll than control fruit. Additional light significantly increased total carotenoid concentrations compared with the control. These results are in support of findings by Ngcobo et al. (2020) who reported that additional light illuminated directly onto the fruit increase the carotenoid content of cherry tomatoes.

Conclusion

It is recommended that tunnel sweet pepper growers employ aluminium foil as a floor covering to harvest and direct additional light onto pepper plants to enhance the total fruit carotenoid concentration, thereby increasing the overall nutritive value of sweet peppers in an environmentally friendly manner.

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- Ramya, V. and Patel, P., 2019. Health benefits of vegetables. *International Journal of Chemical Studies*, 7(2), 82-87.
- Samuels, J., 2015. Biodiversity of food species of the Solanaceae family: a preliminary taxonomic inventory of subfamily Solanoideae. *Resources*, 4(2), 277-322.

Keywords:

Capsicum annum, carotenoids, light intensity, quality

Presenter: Balungile Dlulisa (balu.dlulisa@gmail.com)

Author(s)

#	Name	Affiliation
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2	Miss Balungile P. Dlulisa	I am registered as a member of SASHS

Introduction:

As part of global warming, greenhouse gases (GHGs) have significantly increased in the atmosphere, reaching over 700 ppm at times. Elevated CO₂ (eCO₂) has been reported to encourage growth and development of agricultural crops through positive spin-offs that facilitate plant growth, resulting in increased biomass. The aim of the present study was to investigate whether elevated CO₂ concentration of between 430-500 ppm will induce growth and development as well as early reproductive development in the sweetcorn cultivar STAR7719.

Materials and Methods

The sweetcorn cultivar STAR7719 was grown in the winter season in two well sealed glasshouses adjoining each other. One of the glasshouses had an elevated CO₂ concentration through the use of Mycelium CO₂ generator bags. Nine sweetcorn plants were grown under ambient (400 ppm) as well as under elevated (430-550 ppm) CO₂ concentrations. The performance of the plants under the two growing environments was evaluated.

Results and Discussion

There were no significant differences in days to emergence and emergence percentage, however, during subsequent growth and development, treatment plants displayed significant difference in days to tasselling, anthesis, and silking. Treated plants had a slightly higher leaf number and leaf area, were taller, contributing to enhanced above ground biomass. CO₂ treatment enhanced fresh ear mass and length significantly. Total plant biomass and root mass were found to be significantly enhanced by the CO₂ treatment. Additionally, fresh, and dry root mass were significantly increased under elevated CO₂ conditions.

Conclusion

Elevating CO₂ levels to approximately 500 ppm positively affected biomass, ear mass and size. These findings agree with those of Vanaja et al. (2015) where they observed similar enhanced growth in three genotypes of maize grown under eCO₂ concentrations.

References

Vanaja M.; Maheswari M.; Jyothi Lakshmi N.; Sathish P.; Yadav S. K.; Salini K.; Vagheera P.; Vijay Kumar G. and Abdul Razak. Variability in Growth and Yield Response of Maize Genotypes at Elevated CO₂ Concentration. *Advances in Plants & Agriculture Research*. Vol. (2) 2015

Keywords:

Above ground biomass; ambient CO₂; elevated CO₂; plant size; root mass; sweetcorn

Presenter: Rosemary Du Preez (rosedup@arc.agric.za)

Author(s)

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2	Karen de Jager	ARC-TSC, Private Bag X11028, Mbombela 1200

Introduction:

In essential oil production, the end product quality is of critical importance for successful marketing and profitability and this is strongly influenced by the intrinsic characteristics of the planting stock, soil and climatic conditions and cultural practices. The study assessed the effect of harvesting time on yield and oil quality for rosemary, rose geranium and thyme.

Materials and Methods

Trials were planted at 4 on-farm sites in the Amathole District, Eastern Cape. Material was harvested at different growth stages. Thyme was harvested five and 12 months after planting. Rose geranium was harvested five, seven and 16 months after planting whilst rosemary was harvested 11, 12, 14 and 16 months after planting. Essential oil was extracted using standard steam distillation methods and yield and quality for each crop were determined. Three replicates from each site were harvested to determine oil yield. Oil analysis was performed using gas chromatography-mass spectrometry (GC-MS).

Results and Discussion

Thyme yielded 0.52% essential oil when harvested 5 months after planting whereas material harvested 12 months after planting yielded 0.25% oil. The quality was affected by the age of harvested material. The material harvested five months after planting had a high thymol content of 15.89% while the 12 month harvest had a low thymol content of 8.45%.

Rose geranium yields were similar from all three harvesting times. Material harvested five months after planting yielded 0.15% oil, the seven month harvest yielded 0.13% and the 12 month harvested material yielded 0.15%. Material harvested five months after planting had low geraniol content of 7.2% and a citronellal content of 19.19%. Material harvested seven months after planting yielded 14.24% geraniol and 23.82% citronellal.

Rosemary plants were budding during the harvest at 11 months and full flowering occurred at 14 months. The flowering period was completed 16 months after planting. Material harvested 11 months after planting had a verbenone content of 10.64% and a camphor content of 26%. Material harvested during the start of flowering had a verbenone content of 11.83% and a camphor content of 9.3%. The 14 month material had a verbenone content of 8.59% and a camphor content of 11.9%. Material harvested at 16 months had a low verbenone content of 7.47% and a camphor content of 11.6%.

Conclusion

The trials conducted clearly show the effect of harvest time on oil content yields and particularly on the oil quality. It is important that material is harvested at the correct growth stage to obtain a quality oil.

Keywords:

essential oil; thyme; rose geranium, rosemary; yield; quality;

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Introduction:

There is significant confusion surrounding the naming and identification of litchi cultivars. Currently, cultivars are identified using morphological characteristics but these can be influenced by environmental and other factors leading to misidentifications. Molecular markers provide a tool that can be used to supplement morphological characterisation, particularly in cases where confusion exists. Therefore, the current project investigated the suitability of Simple Sequence Repeat (SSR) markers for DNA fingerprinting and investigation of the genetic relationships between cultivars.

Materials and Methods

Genomic DNA was extracted from leaves using a commercially available kit. A total of 62 litchi cultivars, selections and longans were evaluated. Two published sets of SSR markers were tested, i.e. Viruel and Hormaza (2004) and Tran et al. (2019). The SSR markers were first screened with a phenotypically diverse sub-sample of cultivars. Primers that gave clear peaks and provided non-ambiguous scoring data were used to further analyse selections. The amplification products were visualised via capillary electrophoresis. All reactions were repeated to verify data. Data were analysed in GenAlex and MEGA.

Results and Discussion

The results showed that both sets of markers were suitable for determining relationships between morphological and molecular characteristics, however, the markers developed by Viruel and Hormaza (2004) were more informative for DNA fingerprinting. The markers developed by Tran et al. (2019) did not have the same discriminating power as the markers of Viruel and Hormaza (2004). The limit of resolution of the markers of Viruel and Hormaza (2004) were tested and it was established that these markers could distinguish between groupings of cultivars but could not identify individual cultivars. Specifically, three of the tested markers could reveal differences between groups of cultivars – this was supported by the variability parameters measured for each marker. This is a direct consequence of the close genetic similarity between litchi cultivars and selections. Nevertheless, the markers allowed for the creation of a molecular genotype reference database for cataloguing the germplasm available in the breeding programme.

Conclusion

The results from the current study indicated that none of the tested markers could detect a unique fingerprint for the cultivars. In practical terms, it can be recommended that DNA fingerprinting can be used as a supplementary tool (in addition to morphological characterisation) where cultivar identity is in question. This has to be done on a case-by-case basis, by provision of a suitable comparator and with due consideration of the fact that closely related cultivars will not be distinguished from each other.

Keywords:

Litchi, SSR, DNA fingerprinting, genetic diversity

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Introduction:

The South African Litchi Industry requires suitable, high quality litchi cultivars to extend the short harvesting season. In recent years, several cultivars were imported into South Africa but unfortunately, grafting success was variable due to rootstock-scion incompatibility which is a pre-requisite for successful grafting, ensuring a proper continuum between rootstock and scion. This compatibility is dependent on several variables including anatomical, biochemical, physiological and genetic factors. The aim of the study was early detection of graft incompatibility for selected scion-rootstock combinations.

Materials and Methods

Preliminary studies included visual observations of the range of incompatibility as well as patterns of dye uptake across four rootstocks and several scion cultivars. Subsequently, fifteen litchi cultivars were grafted onto seedling rootstocks i.e. 'Mauritius', 'Brewster', 'McLean's Red' and 'Wai Chee', twenty grafts per combination. Six months after grafting, the grafts were removed from the rootstocks by cutting approximately 50 mm below the graft union and placing into a 0.1% solution of Safranin O for several hours in the direct sun. Transverse sections of the rootstock, graft union and grafted cultivars were visualised for dye uptake and the relative uptake between rootstock, graft union and scion was determined. Further investigations included absolute chlorophyll content using the method of Arnon (1949) as well as assimilation studies (light and temperature response curves).

Results and Discussion

Graft incompatibility caused by a poor rootstock-scion combination leads to unhealthy trees which are prone not only to breakage at the graft union and premature death, but also the inability of surviving trees to perform optimally in the field. It is therefore critical that the callus differentiates and forms the vascular tissues. Although compatibility is difficult to predict, the success of graft compatibility generally only occurs between scions and rootstocks which are taxonomically 'closely' related and therefore incompatible grafts do not form proper vascular continuity due to insufficiently close genetic relationships. This means that a particular rootstock may not be compatible with all scions. In general, total shoot length dovetailed closely with survival rate and to a lesser extent, chlorophyll content. Similarities and differences between the combinations will be discussed.

Conclusion

It is anticipated that the collated results together with an assessment of the genetic relatedness of the cultivars will be used for the development of a model for predicting compatible scion-rootstock combinations prior to the production of healthy young trees in nurseries and subsequent planting.

Keywords:

grafting, incompatibility, Litchi chinensis

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Introduction:

Moderate vegetative growth of commercial apple trees (*Malus x domestica* Borkh.) may improve early flowering and fruit colouration. Prohexadione-calcium (Pro-Ca) is used as a cost-effective foliar application to reduce vegetative growth. In South African growing conditions, shoot regrowth has been noticed following Pro-Ca-induced shoot growth cessation. Flower initiation on shoots will only commence after growth cessation and might therefore be affected by the occurrence of regrowth. This may negatively affect return bloom and crop load in alternation-prone cultivars like ‘Fuji’. This study aims to investigate the effect of Pro-Ca application on return bloom, shoot regrowth, fruit yield alternation and crop load.

Materials and Methods

Experiments were conducted on ‘Fuji’ Akifu® apple trees on M.793 rootstocks at Vastrap farm, Ceres, and ‘Fuji’ Kiku® apple trees on M.793 rootstocks at Cortina farm, Vyeboom, both in the Western Cape Province. Each site contained 70 trees selected according to a randomised complete block design, subjected to ten Pro-Ca treatments (trt) and 7 single tree replications.

1: Untreated control

2: 70 mg.L⁻¹ Pro-Ca applied at full bloom (AFB), 70 mg.L⁻¹ 2 weeks after full bloom (WAFB)

3: 70 mg.L⁻¹ Pro-Ca AFB, 70 mg.L⁻¹ 2 WAFB, 65 mg.L⁻¹ 5 WAFB

4: 70 mg.L⁻¹ Pro-Ca AFB, 70 mg.L⁻¹ 2 WAFB, 65 mg.L⁻¹ 5 WAFB, 65 mg.L⁻¹ 6 WAFB

5: 70 mg.L⁻¹ Pro-Ca AFB, 70 mg.L⁻¹ 3 WAFB

6: 70 mg.L⁻¹ Pro-Ca AFB, 70 mg.L⁻¹ 4 WAFB

7: 70 mg.L⁻¹ Pro-Ca AFB, 70 mg.L⁻¹ 4 WAFB, 70 mg.L⁻¹ 6 WAFB

8: 70 mg.L⁻¹ Pro-Ca AFB, 70 mg.L⁻¹ 3 WAFB, 65 mg.L⁻¹ 5 WAFB, 65 mg.L⁻¹ 6 WAFB

9: 65 mg.L⁻¹ applied 5 times, AFB until 4 WAFB

10: 65 mg.L⁻¹ applied 6 times, AFB until 4 WAFB and 65 mg.L⁻¹ 6 WAFB

Results and Discussion

Trt. 7 was the most effective treatment in suppressing shoot growth. Final shoot length was only significantly different in the Ceres region. The percentage of shoots with regrowth was more pronounced in trees that received Pro-Ca compared to untreated trees. No significant treatment differences were found in fruit yield in agreement with previous research (Miller, 2002; Atay and Koyuncu, 2017).

Conclusion

Preliminary results and observations indicate that Trt. 7 is the best when the goal of application is to suppress shoot growth. Shoot regrowth occurred in all the Pro-Ca treatments but not in the control trees. However, the control trees still had the longest shoots. Crop load, yield and fruit quality were not affected by the application of Pro-Ca.

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Keywords:

Apples, Crop load, Fuji, Plant growth regulator

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Introduction:

Honeybush, an endemic South African fynbos species, is mostly wild harvested with the remaining 20% being cultivated to produce the herbal tea, popular due to its health promoting properties being caffeine-free, having comparatively low tannin and high antioxidant levels (Joubert et al., 2011).

To increase further market access, this emerging industry needs to move from wild harvesting to cultivation.

High mortality rates have been reported, however, for both seedling and cuttings. Three-seasons of field experiments were conducted consecutively in 2014-15, 2015-16 and 2016-17 to study the establishment of honeybush cuttings and seedlings, the effect of glycine betaine on honeybush under water stressed conditions. This preliminary study investigated the establishment of honeybush with regard to differences in species, propagation type, effect of abiotic stress on survival and plant growth.

Materials and Methods

Clonal plant material of *C. genistoides* was collected from the commercial farm Toekoms, near Bredasdorp, whilst similar clonal material was obtained from *C. subternata* cultivated at the commercial farm in Kanetberg, in the Barrydale area. Seed was obtained from the Agricultural Research Council (ARC) honeybush seedbank. Trials were established at three sites at Elsenburg, Outeniqua and Tygerhoek Experimental Farm.

Results and Discussion

This study substantiated establishment differences between plant type and species. Seedlings of both species had a survival rate of between 70-90% and irrespective of the age of the seedlings when planted. However, the survival rate was influenced by cutting age. Seventeen-month-old cuttings had a survival rate of >70% whilst six-month-old cuttings only had a 30% survival rate. The 'reseeder' *C. subternata* growth is more vigorous in comparison to 'resprouter' *C. genistoides*, irrespective of the area of establishment. Thus cutting age at planting and the use of the biostimulant glycine betaine to decrease plant stress increased establishment to 70%, being more in line with the 80-90% survival rate of seedlings observed in this study.

Conclusion

The switch from wild harvesting to cultivation is possible and necessary for the sustainability of the industry as both species in this study established successfully by either cuttings and seedlings. However seedlings survival was higher under dryland conditions in comparison to cuttings. Supplementary irrigation is needed in the initial years of cuttings, increasing cultivation costs, however increase yield of clonal material can negate these costs.

In future, other biostimulants should be investigated to reducing plant stress and nutrient uptake during transplant.

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Keywords:

Biostimulants, *Cyclopia genistoides*, *Cyclopia subternata*, cutting type, phenology, propagation type, clones, germination, glycine betaine,

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Introduction:

Agriculture is adapting to the variability in global climatic conditions, with farmers continually developing strategies to respond to changing weather patterns. Aromatic and medicinal plants are among those plants which are negatively affected by climate change. Therefore, this study aimed to determine the potential ability of plant growth regulators-mixtures (PGRs) to recover the herbage and essential oil yield, as well improve the essential oil quality of simulated hail-damaged rose geranium (*Pelargonium graveolens* L'Her.) plants.

Materials and Methods

The experiment was carried in a 3 x 4 factorial treatment design, laid out in a randomised complete block design in a temperature-controlled greenhouse during the 2019 growing season. The treatments consisted of three hail damage simulation levels: 0% defoliation (intact-plants), and 50% or 100% defoliation, and three PGR-mixtures and a control: level 1, distilled water control; level 2 gibberellic acid (GA) 1.26 mg/kg, brassinosteroids (BRs) 0.51 mg/kg, and traces of cytokinins (CKs) 0.025 mg/kg; level 3, GA 2.55 mg/kg, BRs 1.02 mg/kg, and traces of CKs 0.05 mg/kg; level 4 GA 3.83 mg/kg, BRs 1.53 mg/kg, and traces of CKs 0.075 mg/kg.

Results and Discussion

The number of branches, the branches to height ratio, leaf area, foliar fresh mass (FFM), and the relative growth rate of the stem were all negatively affected by the 100% simulated hail damage. However, these plants grew taller when PGRs-mixtures were applied from levels 2 to 3. The FFM started to increase when PGRs-mixtures were applied from level 3. The change in herbage yield parameters did not affect the essential oil yield for plants that sustained more than 50% foliage loss. Level 3 increased the essential oil yield of the intact plants, as well as plants which sustained up to 50% foliage loss. Essential oil yield results could be associated with the changes in brevicollate trichome; however, this started to occur when PGRs were applied from level 2. Citronellol and geraniol content, and as well the citronellol to geraniol ratio, improved with the level 2, in plants that sustained 100% foliage loss.

Conclusion

It can be concluded that the application of PGR-mixture should be applied at the concentrations of the level 3 treatment, in order to improve the herbage yield and the essential oil quality of rose geranium plants with more than 50% foliage loss. Plants with less than 50% foliage loss can be treated with a PGR-mixture from level 2 to improve the essential oil yield and the densities of the brevicollate trichome.

Keywords:

Biostimulants; Phytohormones; Post hail damage; Recovery

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Introduction:

Drought is a very important abiotic stress that devastatingly affects the growth and productivity of many plants. Honeybush, an essential fynbos plant used for tea production grows in the Mediterranean climate and is subjected to a number of abiotic stress factors, including drought. Understanding the drought-response mechanisms of honeybush at a protein level, is therefore imperative. The objective of this study was to investigate the effect of drought stress on the protein expression profiles of *Cyclopia subternata* plants subjected to different water treatments.

Materials and Methods

Fifteen-month-old *C. subternata* plants were subjected to three water treatments (well-watered control, semi-stressed and stressed) for 10 days. After 10 days of water stress, plants were sampled and analysed for relative water content (RWC) and protein expression using the two-dimensional polyacrylamide gel electrophoresis (2-DE) coupled with mass spectrometry (LC-MS/MS).

Results and Discussion

The RWC of leaves, used to measure a relative change in cell volume as the result of cell turgor and osmotic potential, showed significant differences ($p < 0.05$) between control, semi-stressed and stressed plants after 10 days of water treatments. Plants from control treatments remained significantly higher than semi-stressed and stressed treatments. The RWC for semi-stressed plants slightly declined (90-83%) while at the maximum stress for stressed plants RWC declined reaching the lowest 47%. Plants exposed to drought stress for 10 days were also used for quantitative proteomic analysis using 2-DE, coupled with (LC-MS/MS) identification. A total of 27 differentially expressed protein spots were detected using the PDQuest™. Twenty-four of the proteins were identified by LC-MS/MS while the remaining three proteins were unknown. Thirteen of the identified spots produced significant results based on their Byonic scores. These proteins are involved in photosynthesis, defence, carbohydrates and energy metabolism, stress response, ATP interconversion, protein synthesis and signal transduction. Seventeen of these proteins were upregulated during drought stress, while 7 were downregulated following drought stress.

Conclusion

The study provides valuable information that will lay the foundation for studies investigating the functions of drought response genes in *Cyclopia* species that can be selected to generate plants that are able to produce maximal yields. The results in this study will further assist in the identification of stress-tolerant genotypes of honeybush, ultimately assisting in improving the honeybush breeding programmes.

Keywords:

abiotic stress, drought-response, mass spectrometry, proteins, proteomics, relative water content

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Introduction:

Leucosidea sericea ('Oldwood') is a fast-growing evergreen tree indigenous to South Africa. Oldwood is an important medicinal plant used to treat various ailments due to its antimicrobial properties. The plant has been proven scientifically to be effective against acne. The interest in the material of this plant has increased the need to produce it commercially to provide a uniform supply to the natural products industry. However, production must be done in a way that reduces the invasive nature of *L. sericea* without compromising the quality of the material harvested. The study aimed to determine the effect of pruning and harvesting time on vegetative growth (biomass), flowering and bioactivity of *L. sericea*. A phenological study was also carried out to characterize the growth stages of *L. sericea*.

Materials and Methods

Five trees were used for the phenological study where five branches per tree were tagged to monitor vegetative and flowering phases. Four pruning treatments were applied: pinching the apical tip below the 5th leaf (lightly pruned); pinching the apical tip and the tips of all the primary branches (moderate pruning); pinching the apical tip and cutting the side branches leaving one node from the main stem (severely pruned) and lastly cutting the tree one meter from ground level (moderate pruning). A 4x4 Latin square design was used for the pruning trial. Oldwood leaves were first collected in September 2015 during the first pruning. Subsequently, harvests were made in December 2015, March and June 2016 with the last harvest in August 2016 being the second pruning. For biological activity, leaf extracts of *L. sericea* were tested against *Propionibacterium acnes*. A micro-dilution method was used to determine the MIC values.

Results and Discussion

Leucosidea sericea grows throughout the year with defined peaks of growth flushes. Oldwood flowered from September to October. Harvest time significantly affected the biomass, however, there was no significant difference on biomass in terms of pruning techniques. Flowering was significantly affected by pruning techniques as the trees that were severely pruned produced significantly lower number of flowers. Oldwood generally had good activity against *P. acnes* as values recorded were less than 1.0mg/ml. Harvest time and pruning techniques influenced the bioactivity of oldwood.

Conclusion

Plant material of *L. sericea* can be harvested all year round as the plant is evergreen and had high activity. Pruning the trees severely can improve plant growth while reducing unwanted flowering and subsequent seed production and therefore reducing the reproductive capacity of oldwood.

References

Keywords:

Antibacterial, Phenology, Pruning

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Introduction:

Helichrysum odoratissimum 'Imphepho' is a popular indigenous SA herb, renowned for its aromaticity. 'Imphepho' was selected due to its photoprotective effects. Information on the phenological stage of the plant is needed in order to develop a production method to ensure sustainable supply of good quality material for commercialization. Therefore, phenology and production of 'Imphepho' were evaluated.

Materials and Methods

Phenological observations were done weekly at Afriflowers nursery over 2 years (2019-2020). Ten plants were planted on the ground, only five plants were tagged and phenological changes (vegetative growth, flowering, senescence and dormancy) were recorded. Germination study was executed at TUT laboratory. A Youden square design was used, with 3 replicates. Seeds were pre-treated with four seed priming methods; control, smoke, cold and hot water, then incubated at five temperature levels (10-30°C, 5°C increments) for 46 days. The radicle (2mm) indicated germination. Vegetative propagation was conducted at Afriflowers nursery. A Randomised Complete Block Design with three replicates was used. Stem cuttings were made seasonally on cutting position (apical, median), rooting hormone (dip 'n root, dynaroot1 and control) and growth media (sand, perlite and vermiculite (1:1:1), compost and coco peat (2:1) and pine bark, vermiculite and sand (2:1:1)). After 10 weeks cuttings were evaluated for number of cuttings survived and rooted, number of roots and root length.

Results and Discussion

'Imphepho' grows vegetatively all year round, except Winter, when it initiates dormancy. Its reproductive phase starts during Spring until Summer (September-mid February). Irrespective of the temperature used, seeds primed with smoke water had a higher germination percentage (91,7% at 20°C), while hot water (45°C) inhibited germination at all temperature regimes. This may be due to the damage of the embryo caused by high water temperature, while smoke water is known to enhance germination. Vegetative propagation, almost all factors tested had a high significant effect in all parameters measured except the cutting position which had no effect on survival and rooting ability of the cuttings. Approximately 67% of the cuttings planted during Autumn survived and about 63% of the cuttings rooted, while the lowest survival (34%) and rooting (33%) was obtained in Summer.

Conclusion

'Imphepho' seeds may be harvested at the end of Summer (seed dispersal stage), primed with smoke water and incubated at 10°C to 20°C to achieve higher germination. Cuttings may be harvested throughout the year except during mid-Winter, when the plants die back and may be planted during cooler seasons (Autumn) for higher rooting and survival rates.

Keywords:

Helichrysum, Production, Phenology

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Introduction:

Despite the rapid growth of the essential oil industry in South Africa, very little is known regarding the effect of crop management on the productivity of these crops. Therefore, the aim of this study was to identify the best practices for some of the most important agronomic factors on selected high-value essential oil crops.

Materials and Methods

A pot trial was conducted under controlled environment in glasshouses at the Agricultural Research Council - Vegetable, Industrial and Medicinal Plants (ARC-VIMP), Pretoria. Six high-value essential oil crops (rose geranium, yarrow, lemon balm, rosemary, thyme and marjoram) were grown in 5 L plastic pots filled with three different soil types (sandy clay loam, loamy sand and sandy loam), irrigated at 20, 40, and 60% soil water depletion from field capacity and fertilized with 100, 150, and 200 kg of nitrogen per hectare which were split into three applications per growth period after planting. A factorial arrangement of all possible treatment combinations was laid out in a randomized complete block design with three replications, inside three glasshouses with different temperature regimes of 15 - 20, 20 - 25, and 25 - 30°C. Data recorded on growth, herbage yield, and oil yield were subjected to analysis of variance using Genstat®11.1 and the least significant difference test.

Results and Discussion

Initial results from the first harvest showed significant differences in terms of crop productivity. On average, the highest herbage yield was observed from lemon balm, followed by rose geranium under the highest temperature regime, with both from the sandy loam textured soil under high fertilization rates. Marjoram and thyme presented greatest herbage yield under high regimes of temperature, irrigation and fertilizer, particularly under the sandy loam soil. Yarrow and rosemary were best under low regimes of temperature and irrigation, high levels of fertilization under the sandy loam soil. Lemon balm and rose geranium gave higher oil yield (0.016 - 0.602 and 0.014 - 0.561%, respectively) compared to the remaining crops (0.013 - 0.260 %) while yarrow gave the least oil yield (0.0003 - 0.022%) under all conditions tested.

Conclusion

The productivity of essential oil crops is highly affected by crop management practices. Rose geranium, lemon balm, marjoram and thyme can attain maximum productivity under warm conditions on sandy loam soils, with increased irrigation and fertilization regimes. This information can be used in planning cultivation of the selected essential oil crops and for better inferences these results should be validated under field conditions.

Keywords:

Keywords: lemon balm, marjoram, rose geranium, rosemary, thyme, yarrow.

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Introduction:

Water use efficiency (WUE) and nutritional water productivity (NWP) are threatened by water scarcity particularly in South Africa, where the average annual rainfall is far below the atmospheric evaporative demand. Therefore, it is crucial to adopt climate-smart crop production systems to conserve the scarce water resources, while combating malnutrition. The open-bag hydroponic system (known as bag culture) is one of the adopted strategies for climate-smart crop production. Thus, the aim of this study was to improve food and nutritional security through adequate production of leafy vegetables using a bag culture system in a semi-arid area of South Africa.

Materials and Methods

An on-farm trial was conducted during the 2019/20 season under the open field in Mamelodi, Gauteng Province, South Africa. Research treatments were laid out in a 2 x 2 x 2 factorial arrangement with three replicates in a randomized complete block design. Three factors were investigated: (1) production system: open-bag and conventional soil cultivation; (2) planting density - low (24 plants/bag and 7.0 plants/m² for the open-bag and conventional soil cultivation respectively) and high density (48 plants/bag and 33.0 plants/m² for the open-bag and conventional soil cultivation, respectively); and (3) spacing – narrow (0.5 m x 0.5 m and 0.2 m x 0.15 m for the open-bag and conventional soil cultivation, respectively) and wide spacing (1.0 m x 0.5 m and 0.45 m x 0.3 m for the open-bag and conventional soil cultivation, respectively).

Results and Discussion

There were significant differences between treatment interactions in terms of crop yield and quality. The bag culture system with high planting density and narrow spacing (NS B HPD) had significantly higher yield (6.2 kg m⁻²) and WUE (36.5 kg m⁻³) compared to conventional soil production with low planting density and narrow spacing (NS F LPD) with 5.1 kg m⁻² and 18.0 kg m⁻³, respectively. Furthermore, the NS B HPD had significantly higher NWP in terms of β -carotene (547.8 mg m⁻³), Iron (25548 mg m⁻³) and Zinc (3485 mg m⁻³) compared to conventional soil production with low planting density under wider spacing (WS F LPD) in terms of β -carotene (252.7 mg m⁻³) and NS F LPD in terms of Iron (17800 mg m⁻³) and Zinc (962.03 mg m⁻³).

Conclusion

The bag culture implemented at high planting density resulted in maximum yield, WUE and NWP of Swiss chard. This climate-smart production system demonstrated to be beneficial for improved food and nutritional security, while using land and water resources efficiently.

References

Keywords:

water use efficiency, nutritional water productivity, climate-smart system.

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Introduction:

Capsicum frutescens L. (chili pepper) is an important spice and cash crop mostly produced under adverse climatic growing conditions, such as erratic rainfall, water scarcity and escalating temperatures. Exploring various systems of production for chili that can counter climatic challenges while increasing growth and yield remain of utmost importance. The aim of this study was to determine the response of chili to planting density produced under open-field and closed hydroponics system.

Materials and Methods

A factorial study of two production systems (Open-field and closed hydroponics having 480 plants each) and four planting density treatments (111 111 p/ha; 66 667 p/ha and 41 667 p/ha; 33 333 p/ha) with four replicates each, was conducted at the Agricultural Research Council-Vegetable, Pretoria in October - April (2017-2018 & 2018- 2019). Fertiliser was applied in the field before planting, 14 days after transplanting and 30 days after transplanting (47 kg/ha limestone ammonium nitrate, 67 kg/ha monoammonium phosphate & potassium chloride. Drip irrigation was used with a one-day interval for two hours to irrigate the plants. Chili was subjected to gravel-film technique under the closed hydroponic system (Shade net) which is explained by Maboko and du Plooy (2008), having 1 m wide, 17 m long rows with a nutrient solution containing 3kg hygroponic and calcium nitrate per tank for 2.5 mS/cm. Plant height, leaf area index, and chlorophyll content were recorded biweekly

Results and Discussion

Planting density of 111 111 plants/ha led to increased fruit number, yield, plant height, leaf area index, earliest days to flowering and fruit initiation from both open-field and closed hydroponics systems. The planting density of 111 111 p/ha had a fruit yield of 197 fruit/plant and fruit mass of 4.3 t/ha under the hydroponics system whereas the field had 189 fruit per plant and 4.1 t/ha. Statistically, there was no significant difference between the two production systems. However, the open field had taller plants, more chlorophyll content and more leaf area index as compared to hydroponically produced. A Closed hydroponics system produced longer and wider leaves, more branches, more leaves, yield, bigger and longer fruits as compared to open-field.

Conclusion

A closed hydroponics system and the planting density of 111 111 p/ha showed potential as a method of cultivation for chili. Therefore, the Adaptation of chili production under the hydroponics system is recommended to mitigate climatic challenges and to adequately maximise arable land.

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Keywords:

Chili, hydroponics, open-field, planting density

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3	Dr. Kara-Lee Prinsloo	Department of Horticulture, Tshwane University of Technology, Private Bag X680, Pretoria, 0001.

Introduction:

Buddleja saligna and *Euclea natalensis* are used widely in traditional medicine for a variety of treatments and ailments, and also for cosmeceutical and ornamental purposes. Many studies have investigated the efficacy and safety of the leaf extracts; however, propagation and cultivation information is limited. Although plant material is available in nature, different environmental conditions such as soil pH and temperature may cause variation in extract quality. In order to assist in the production of these plants, this project aimed to develop protocols for the propagation of *B. saligna* and *E. natalensis*.

Materials and Methods

For seed germination and emergence trials, ten seeds for both species were used as an experimental unit and placed in Labcon™ incubators under continuous dark conditions for 30 days. For each replicate, the Labcon™ incubators served as a row of temperatures regimes that ranged from 10 °C, 15 °C, 20 °C, 25 °C, to 30 °C and changed according to a 5 x 5 Latin square design. For vegetative propagation trials, stem cuttings were used to test the effect of cutting position, media, plant growth regulator, and season. A randomized complete block design was replicated three times in four seasons using five cuttings per treatment combination as an experimental unit for *B. saligna* and *E. natalensis*.

Results and Discussion

Buddleja saligna seeds had the highest germination percentage (96%), and best mean emergence time (3.9 days) at 25 °C, although seed were able to germinate over the whole range of temperatures. However, for *Euclea natalensis*, 20 °C recorded the highest germination percentage (98%) and no significant germination was observed at 10-15°C. Many species can have widely different minimum and maximum temperatures (Bewley and Black, 1994). Apical cuttings of *Buddleja saligna* survived (67.3%) better than basal (57.8%) cuttings. In certain species, cuttings from the basal to mid-position may root the best, whereas in other species apical cuttings may root the best (Soh et al., 2018). All *Euclea natalensis* cuttings in all treatments died after three weeks in all seasons. The species in the Ebenaceae family are known for being difficult to produce from cuttings (Mehra et al., 2019).

Conclusion

Seed propagation of both species was more effective than vegetative propagation. However, for the production of uniform and high-quality extracts (for use in the natural products industry), seed propagation is not ideal, because it can lead to variation. More research should be conducted to establish vegetative propagation protocols for both species.

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Keywords:

Germination, seedling emergence, temperature, traditional medicine, vegetative propagation

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Introduction:

Cancer bush (*Sutherlandia frutescens* (L.) R.Br) is a legume, currently under intensive destructive harvesting. In order to preserve this plant from extinction, successful cultivation would require effective rhizobia bacteria for nodulation. The development of an effective nodulation bacteria would be provide a cheap inoculant and reduce the use of inorganic nitrogen fertilisers, which are environment un-friendly and costly (Zuluaga *et al.* , 2020). The first step in assessing the suitability of indigenous nodulation bacteria is comparing their efficacy with the existing commercial strains on plant growth variables and biosynthesis of nitrogen and proteins. The null hypothesis stated that the efficacies of natural *S. frutescens* nodulation bacteria would not be similar to those of commercial nodulation bacteria on growth, selected macronutrients and protein of *S. frutescens* .

Materials and Methods

The five treatments, namely, *Bradyrhizobium* spp. (Arachis) strain, *Rhizobium leguminosarum* strain, Tubatse strain (*Raoutella ornithinolytica* and *Enterobacter cloacae* species dissolvens) and Sebayeng strain(*Sphingomonas paucimobills* , *Raoutella ornithinolytica* and *Enterobacter cloacae* species dissolvens) isolated previously in our project and untreated control, were laid-out in a randomised complete block design, with seven and eight replications in two successive years under microplot conditions at University of Limpopo, South Africa (23°53'10"S, 29°44'15"E). At 110 days after transplanting plant variables and selected macronutrients and protein content of cancer bush were determined.

Results and Discussion

The seasonal interaction on plant and nutrient elements were not significant ($P < 0.05$) and data for the two seasons were pooled ($n = 75$). At 110 days after transplanting, treatments had a significant effect on plant height, root length, dry root mass, dry nodule mass and nodule number, contributing 87, 58, 66, 71 and 91% in total treatment variation (TTV) of the respective variables. Relative to untreated control, commercial and native strains significantly increased plant height, root length and dry shoot mass by 31, 33, 44 and 40%, 30, 41, 40 and 42% and 48, 195 and 17%, respectively. Similarly, commercial, and native strains significantly contributed to the increase in nitrogen, protein, and symbiotic efficiency by 7, 25, 80 and 13%, 10, 24, 69 and 13% and 31, 133, 292 and 82%, respectively.

Conclusion

The study demonstrated the potential superior presence of effective native nodulation strains that compared favourably with commercial strains in nodulation, symbiotic efficiency, macronutrients, protein content and growth performance of the test plants. Further characterisation and mapping is necessary in development of effective and affordable commercial inoculants for the test plant species.

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Keywords:

Bradyrhizobium species, native strains, Rhizobium species symbiotic efficiency.

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Introduction:

Climate change projections indicate warming across South Africa and differential changes in rainfall. Long-term adaptation planning is vital for perennial fruit crops. The research aim was to model and map changes in key climatic parameters of importance to pome and stone fruit production in the Western Cape of South Africa, including the Langkloof valley in the Eastern Cape, and to identify adaptation priorities for each of the eleven sub-regions.

Materials and Methods

The modelling and mapping of selected parameters relating to temperature, rainfall and their derivatives was based on existing databases, with additional modelling conducted of the impacts on fruit quality including sunburn and poor red colour development. Three sets of General Circulation Models (GCMs) were used for the modelling of future climates. Maps were produced at provincial scale and at high resolution for eleven pome and stone fruit sub-regions. The future timeframes were either the 2030s or 2050s, relative to the period 1950-1999.

Results and Discussion

The impacts of warming (+ ~2°C by mid-century) and associated changes in potential evaporation, frost risk, chill units, heat units, sunburn, red colour and insect pests are area-specific. Pome fruit production is most at risk in the south-western coastal production regions (e.g. Elgin) owing to losses in winter chill, but these areas become more suited to stone fruit. The north-western high-lying regions (e.g. Bokkeveld) and the Langkloof remain suited to pome fruit production from a winter chill perspective, but growers will have to adapt to high temperature risks. In all pome fruit regions, the loss of days in autumn that are conducive to red colour development of apples will require a greater use of high-colouring cultivars and mutants. For stone fruit production, the warmer parts of the Klein Karoo could become more marginal. The northern parts of the Berg River region are projected to become much warmer and possibly drier than at present. Climatically suitable stone fruit cultivar choices will become an important component of adaptation responses. In all production regions, rising evapotranspiration will increase the irrigation demand, and water resources availability and efficient irrigation strategies will become critical.

Conclusion

Different production regions are affected differentially, and opportunities exist for continued pome and stone fruit production with adaptations. These must be addressed in a spatially explicit and crop-specific manner. We recommend further research on alternative production regions outside the Western Cape / Langkloof, and continued research on cost-effective adaptation approaches and technologies.

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Stellenbosch: Hortgro Pome and Hortgro Stone.

Schulze RE (Ed.) 2016. Handbook for Farmers, Officials and Other Stakeholders on Adaptation to Climate Change in the Agriculture Sector within South Africa.

Keywords:

Adaptation, chilling, climate change, evapotranspiration, growing season climate, red colour development

INTERACTIVE EFFECTS OF ENVIRONMENT, CULTIVAR, SIZE OF CUTTING, HORMONE APPLICATION AND GROWING MEDIA ON SPROUTING AND ROOTING OF CASSAVA CV 'MBONISWENI' AND CV 'MGANDUZWENI' CUTTINGS

Oral

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Introduction:

Cassava (*Manihot esculenta* Crantz) propagation research has focused mostly on the production of disease-free cuttings (Aladele and Kuta, 2007). However, yield of cuttings is also affected by the interaction of various conditions such as cultivar, cutting size, media, etc (Ly et al., 2013). Therefore, the objective of the study was to investigate the interactive effects of the above-mentioned factors in two locally produced cassava cultivars from small holder farmers in Mbonisweni and Mganduzweni.

Materials and Methods

A $2 \times 2 \times 2 \times 2 \times 3$ factorial experiment was laid out in a randomised complete block design with 5 replications, factors being Environment (inside and outside laboratory); Cultivar (cassava cv. 'Mbonisweni' and cassava cv. 'Mganduzweni'); Media (peat and loam soil); rooting hormone (IBA and water) and size of cuttings (small, medium and large).

Results and Discussion

Cassava cv. 'Mbonisweni' had optimum growth when exposed to IBA and peat outside laboratory conditions while cassava cv. 'Mganduzweni' performed similarly in both growing media. However, IBA rooting hormone did increase the number of roots in this cultivar also. Inside laboratory, cassava cv. 'Mganduzweni' had the highest sprout length. Peat and IBA improved sprouting and rooting of both cultivars, this is in line with Usman and Akinyele (2015) findings.

Conclusion

Environment, growing media and the size of cuttings play a crucial role in cassava production, it is important to stimulate rooting in cuttings grown outside and the use of peat is also important.

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Keywords:

cassava, propagation, environment, media, hormone, cuttings

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5	Dharini Sivakumar	Phytochemical Food Network Research Group, Department of Crop Sciences, Tshwane University of Technology, Pretoria, South Africa

Introduction:

Anthracnose decay is one of the major causes of postharvest losses of avocados (*Persea americana*), during marketing. Currently, hazardous fungicide (Prochloraz®) is used to control anthracnose after harvest which poses a threat to consumer safety. Therefore, this study evaluated the effects of high and low molecular weight chitosan on the control of avocado anthracnose and fruit defense mechanism.

Materials and Methods

Avocados (Fuerte cv) were curatively inoculated with *Colletotrichum gloeosporioides* spores (1x10⁶ spores/ml) and were randomly distributed into eight treatments in three replicate boxes of fifteen fruit each and thereafter coated with three different concentrations (0.5%, 1% and 1.5%) of low (LMWC) and high molecular weight (HMWC) chitosan. Fruit treated with Prochloraz® and water were included as controls. Inoculated fruits were incubated for 28 days at 6.5 °C, 85% RH and thereafter for 5 days at room temperature (75% RH). The anthracnose incidences, severities and skin epicatechin content, were evaluated. The promising chitosan coatings with the lowest anthracnose incidence and the controls were investigated for defense-related genes; phenylalanine ammonia lyase, lipoxygenase, fatty acid elongase, Δ 12 fatty acid desaturase, chalcone synthase and flavonol synthase using RT-qPCR method (Bill et al. 2017).

Results and Discussion

Percentage of anthracnose incidence and severities were lowest in 1.5% LMWC (18%, 3 mm) compared to Prochloraz (23%, 5 mm) and the untreated fruit (90%, 24 mm). The 1.5% LMWC had the highest up-regulation of phenylalanine ammonia lyase, Δ 12 fatty acid desaturase, fatty acid elongase, chalcone synthase and flavonol synthase genes and down-regulation of lipoxygenase gene with concomitant increase in epicatechin content (340 mg/kg) relative to other treatments, untreated fruit and Prochloraz®.

Conclusion

Chitosan (LMWC 1.5%) effectively controlled anthracnose in infected avocados following the phenylpropanoid and diene pathways. Therefore, LMWC 1.5% could be used to replace the currently used Prochloraz®.

References

Bill, M, Korsten, L, Remize, F, Glowacz, M, Sivakumar, D. 2017. Effect of thyme oil vapours exposure on phenylalanine ammonia-lyase (PAL) and lipoxygenase (LOX) genes expression, and control of anthracnose in 'Hass' and 'Ryan' avocado fruit. *Scientia horticulturae*, 224: 232-237.

Keywords:

Colletotrichum gloeosporioides, edible coating, *Persea americana*, transcriptome analysis, phenylpropanoid pathway, postharvest decay

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Introduction:

Recirculating hydroponics is viewed as an important strategy to improve water use efficiency. It is known for its excellent quality of fresh produce and uniform growth improvement. This is due to its even watering and fertilization. However, the availability of operating resources such as water and fertilizers is becoming scarce and expensive. Therefore, more efficient practices need to be adopted for sustainable crop production. Hence, the aim of this study was to assess the response of leafy herbs (example of sweet basil) to varying electrical conductivity (EC) levels and water flow rates in a gravel film recirculating hydroponic system.

Materials and Methods

An experiment was conducted during the summer season of 2020-2021 at the Agricultural Research Council – Vegetable, Industrial and Medicinal Plants, Pretoria. The study factors consisted of three EC levels (1.0-1.5, 2.0-2.5 and 3.0-3.5 mS/cm) and two water flow rates (24 and 48 L/h), arranged in a randomized complete block design with three replications. Sweet basil seedlings were planted in gravel film beds at 20 cm x 20 cm spacing. Data recorded on crop yield and marketable quality were subjected to analysis of variance using Genstat® 11.1 and the Fischer's means were separated at 5% level of difference using Fisher's least significant difference test.

Results and Discussion

The results demonstrated that there were no significant interactions between EC levels and water flow rates. Unlike water flow rates, EC levels affected growth and yield parameters measured. Electrical conductivity levels of 2.0-2.5 and 3.0-3.5 mS/cm had highest and comparable total marketable yield of 6.0 and 6.3 kg m⁻², respectively, whereas the lowest level 1.0.- 1.5 mS/cm had lowest marketable yield at 0.7 kg/m². However, with regard to water use (WU) and water use efficiency (WUE) the 24 L/h flow rate resulted in significantly low WU (11.14 L/plant) and high WUE (10.3 kg/m³), whereas 48 L/h had high WU (19.87 L/plant) and lower WUE (5.38 kg/m³). Overall, the 24 L/h flow resulted in high WUE and low WU, and gave similar marketable yield (4.2 kg/m²) and 48 L/h flow rate gave (4.1kg/m²).

Conclusion

In a gravel film recirculating hydroponic system, sweet basil responded most efficient when using an EC level of 2.0-2.5 mS/cm and a water flow rate of 24 L/h. An identification of the optimum EC level of the nutrient solution and water flow rate will contribute to increased marketable yields, income generation and profitability of farmers, while saving water and fertilizers utilization.

Keywords:

water use efficiency, recirculating hydroponics, herbs, fertilizers.

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Author(s)

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4	Prof. Dharini Sivakumar	Supervisor of the study
1	Mr Azola Siwaphie Mpeluza	Author of the study
3	Prof. Fabienne Remize	Provided cultures for the study

Introduction:

In spite of avocado being economically significant, it is often affected by anthracnose (*Colletotrichum gloeosporioides*) diseases, which lead to loss of postharvest earnings. Currently, anthracnose is controlled with a fungicide (Prochloraz®), which poses a threat to consumers. Hence, it is necessary to find an alternative to Prochloraz before its phasing out in 2022. This study investigated the efficacy of Lactic acid bacteria (LAB) strains; *Weissella cibaria* 21 (LAB 21), *Leuconostoc pseudomesenteroides* 56 (LAB 56), *Weissella confusa* 17 (LAB 17), *Lactiplantibacillus plantarum* 75 (LAB 75), *Lactiplantibacillus plantarum* 171 (LAB 171) in controlling anthracnose using the curative in-vivo experiment.

Materials and Methods

Trigger ripe avocado fruits (Fuerte) were inoculated with *C. gloeosporioides*, and randomly distributed into seven treatments of three replicate boxes having six fruits each. Inoculated fruits were dipped in respective LAB cells (6 Log CFU/ml). Sterile distilled water (SDW), and Prochloraz® (PR) served as controls. Inoculated avocados were cold stored (7 oC) for 28 d and held at 25±2 oC to simulate the market shelf conditions. Anthracnose incidences and severity were observed after five days. The impact of promising LAB treatments on defence related genes; Phenylalanine ammonia-lyase (PAL), chalcone synthase (CHS), and fatty acid desaturase (avfadl 2-3) were determined on using RT-qPCR method (Bill et al. 2017). Actin gene was used as a normaliser gene and the relative fold increase ($2^{-\Delta\Delta Ct}$) of assayed genes relative to the control (SDW) were determined. Epicatechin was also determined in the avocado pericarp (Bill et al. 2017).

Results and Discussion

Anthracnose incidence and severity significantly ($p < 0.05$) reduced in LAB's treated avocados compared to SDW (89%, 18%) and PR (44%, 6%) respectively and was lowest in LAB 56 (38.9%, 5%) while LAB 21 (44%, 8%) was not significantly different to PR and LAB 17 ($P > 0.05$). However, LAB 21 had the highest epicatechin content (406 mg/g) and up-regulation of PAL and avfadl 2-3 genes while CHS was significantly up-regulated in LAB 56 treated avocado compared to LAB 21, SDW and PR.

Conclusion

The LAB 21 or LAB 56 reduced anthracnose incidence by influencing genes involved in the phenylpropanoid pathway and the AVFL 2-3 genes in *C. gloeosporioides* infected avocado fruit. In addition to LAB 21, LAB 56 can be used as a biocontrol agent to reduce anthracnose incidence in avocado fruit. However, further investigation is needed.

References

Bill M, Korsten L, Remize F, Glowacz M, Sivakumar D. 2017. Effect of thyme oil vapours exposure on phenylalanine ammonia-lyase (PAL) and lipoxygenase (LOX) genes expression, and control of anthracnose in 'Hass' and 'Ryan' avocado fruit. *Scientia horticulturae*, 224: 232-237.

Keywords:

Anthracnose, Avocado, *C. gloeosporioides*, Lactic acid bacteria, Prochloraz.

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Introduction:

Hypoxis hemerocallidea is one of the most used commercially medicinal species in South Africa. The species is overharvested, which poses a threat to its sustainability in the wild. Increasing commercial use necessitates effective propagation to ensure a sustainable supply of plant material. Seeds of *H. hemerocallidea* are difficult to germinate due to seed dormancy, partly resulting from a hard seed coat. The study aimed to investigate pre-sowing treatment methods to overcome seed dormancy.

Materials and Methods

The germination trials were conducted at TUT laboratory. For all treatments, 3 seed ages (fresh, 1 and 2 year old) were germinated in petri-dishes at 25°C in a growth cabinet. A RCBD with 4 replicates were used. Treatments included: Chemical- submerging seed 1200ppm GA3 and 4% KNO3 (Shaik et al., 2014). Wet heat followed by ice water - seeds were dipped in boiled water for 3, 5, 7, 9 and 11 minutes and then placed into ice water for two minutes. Stratification/hot water soaking combination – seeds were stratified (at 4 °C) for five different durations (3, 5, 7 and 9 weeks) and then subjected to five hot water treatment durations (1, 2, 3 and 4 days). Hot water treatments consisted of pouring boiling water over the seed daily and then letting the water cool down and lastly microwave treatment -(0, 5, 10, 15, 20, 25, 30 sec) in a 900-watt microwave (at full power) (Venkatesh and Raghavan, 2004).

Results and Discussion

The highest average germination percentage (34%) was achieved with a 15 seconds microwave pre-treatment. Seed age had no significant effect on all the germination parameters measured and is not perceived to be the limiting factor in seed germination of *H. hemerocallidea*. Hot and cold-water treatments were not successful in stimulating germination. The seed, however, seem to have a very strong circadian rhythm and various treatments were effective (up to 60% germination) when applied during late spring and summer months, but no germination was observed for the same treatments during winter and autumn.

Conclusion

Dormancy was overcome to some extent by the suspected circadian rhythm (A specific phenological time) as untreated seeds germinated during specific times of the year. Timing of seed germination should be investigated further, to ascertain the best time of the year for *H. hemerocallidea* seed germination and if that is related to a circadian clock mechanism and hormonal differences in the seeds. Exploring different microwave power levels (Watts), should receive further attention to assess possible mutations.

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Keywords:

Germination, *Hypoxis* sp, dormancy, propagation.

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Introduction:

The present study was conducted to compare the efficacy of aqueous with chemical solvents to determine, which extractant yields the best growth-enhancing effects of Moringa Leaf Extract (MLE), when applied to leaves of tomatoes and peppers.

Materials and Methods

Foliar application of MLEs tested in this study included: Control (water with no MLE), MLE extracted with hot water (MLE HW), MLE extracted with cold water (MLE CW), MLE extracted with ethanol (MLE ETH) and MLE extracted with methanol (MLE METH). These extracts were repeatedly sprayed directly onto the leaves of selected pepper and tomato plants to run-off, from two weeks after transplanting in weekly intervals until fruit set. Growth parameters were recorded immediately after the first foliar application, while yield and nutritional quality attributes were assessed post-harvest, when fruit were red ripe.

Results and Discussion

Foliar application of MLE HW, MLE ETH, MLE METH and MLE CW significantly enhanced growth of both, pepper and tomato plants compared with the control. Application of MLE HW affected yield parameters most positively, followed by MLE ETH and MLE METH, while MLE CW altered yield parameters. Colour coordinate a (red to green) and TSS were significantly enhanced by foliar application with MLEs, excluding MLE CW. Similar to colour and TSS, carotenoids in red peppers were significantly higher, following all MLE treatments, excluding the MLE CW, while in red tomatoes MLEs enhanced, or tended to enhance, lycopene and β -carotene. The concentration of Vitamin C was also significantly enhanced by MLE application to peppers, while, in tomatoes, only MLE METH and MLE ETH positively altered the fruit Vit C concentration. Most notably, MLE HW tended to outperform the organic solvent extracts in enhancing growth and yield parameters of solanaceous tomatoes and peppers.

Conclusion

It can be inferred that MLEs, particularly hot water MLE, hold the potential to enhance growth, yield and nutritional quality of solanaceous fruit crops, such as pepper and tomato. Results presented in this research are of high significance to both, commercial and small-scale pepper and tomato growers, as hot water extracts, a sustainable and environmentally friendly approach, outperformed other treatments. The positive effect of MLE HW on tomato and pepper requires further investigation.

References

Keywords:

Extraction, Foliar application, MLE biostimulant, Solanaceous fruit crops, Solvents

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Introduction:

Apple production has shifted from low to high-density planting with the use of high-yielding, dwarfing rootstocks. It is becoming important for the South African industry to follow suit to remain globally competitive. The performance of an apple tree may be affected by the chosen rootstock genotype (G), the environment (E) in which the tree is planted, and the interaction of the G and E (GEI) (Li *et al.* , 2017). The GEI causes difficulty in the selection of a superior rootstock genotype, requiring evaluation of the GEI to infer stability and select a suitable rootstock genotype. The objectives of this study were to (i) select high-yielding and stable dwarfing apple rootstock genotypes using parametric and nonparametric stability analysis; and (ii) identify the most accurate stability analysis to investigate the GEI in apple rootstocks.

Materials and Methods

Ten dwarfing apple rootstock genotypes were planted in a randomised complete block design during the 2013 season, with 'Fuji' as a scion, across three environments: Breëvlei and Oak Valley Estate in the Western Cape Province, and Helderwater, in the Eastern Cape Province. The GEI was evaluated using parametric and nonparametric stability analysis.

Results and Discussion

Breëvlei was ranked as the most favourable environment. This may be due to differences in tree management, such as the number of times trunk renewal was performed and the training system used. The parametric and nonparametric stability analyses all ranked the combination of G.778 with a M.9 EMLA interstem (G.778/M9), and G.778 with a G. 222 interstem (G.778/G.222) as the most stable, and high-yielding rootstock genotypes. The selected rootstock genotypes comprised of rootstocks from the Geneva® series, which are highly precocious and productive (Reig *et al.* , 2018).

Conclusion

The most stable and high-yielding dwarfing apple rootstock genotype combinations, suitable for the most favourable and least favourable environments were G.778/M.9 and G.778/G.222. These rootstock combinations are thus widely adaptable. The geometric adaptability index, BLUP-based models, the Schmoldt index and the superiority index were positively correlated to apple yield traits and may thus be used in the selection of stable and high-yielding apple rootstock genotypes in the future.

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Keywords:

GEI, Parametric, Nonparametric, Stability, Rootstocks

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Introduction:

DNA-based methods have been developed for characterizing rhizobia (Andrews and Andrews 2017). In this regard, Sequencing and phylogenetic analyses of the 16S ribosomal RNA (rRNA) gene, housekeeping genes and symbiotic genes have been routinely used for bacterial taxonomy (Chidebe et al. 2018). Despite their importance in improving soil health and fertility, there is limited information on the genetic diversity and biogeographic distribution of native N₂-fixing rhizobia in Sub-Saharan Africa (Liu et al. 2014). This study assessed the genetic diversity and phylogenetic relationships of rhizobial isolates obtained from root nodules of groundnut (*Arachis hypogaea*), jack bean (*Canavalia ensiformis*) and soybean (*Glycine max*) planted in different locations within Eswatini.

Materials and Methods

Some 87 rhizobial isolates were studied using ERIC-PCR, fingerprinting and PCR amplification of 16S rRNA, housekeeping genes and symbiotic genes. The PCR amplification was performed in a Thermal cycler. The amplified PCR products were sequenced at Macrogen (Netherlands) and the quality of the sequences were assessed using the software BioEdit 7.0.9.0. Closely related species were identified using the BLASTn program in the NCBI (National Centre for Biotechnology Information) database. Phylogenetic trees were constructed using MEGA 7 software by means of the maximum likelihood statistical method.

Results and Discussion

The dendrogram generated from the ERIC-PCR banding patterns grouped the test rhizobial isolates into 14 major clusters (Cluster I to XIV), with isolate TUTGMeS3 as an outgroup of Cluster II. Furthermore, the 87 test isolates were grouped into 66 ERIC-PCR types at 70% similarity level. The phylogenetic analysis of the 16S rRNA gene and multilocus sequence analysis of four housekeeping (*atpD*, *dnaK*, *glnII* and *rpoB*) and two symbiotic (*nifH* and *nodC*) genes showed that all three legumes (groundnut, jack bean and soybean) were nodulated by bacterial symbionts belonging to the genus *Bradyrhizobium*, with some isolates exhibiting high divergence from the known reference type strains. In this study, the results also showed that *B. arachidis*, *B. iriomotense* and *B. canariense* were the closest type strains to the groundnut isolates, while *B. pachyrhizi* and *B. elkanii* were as the closest relatives to the bacterial symbionts associated with the nodulation of both jack bean and soybean.

Conclusion

The current study identified the rhizobia responsible for nodulating groundnut, jack bean and soybean in Eswatini. The observed genetic divergence of most groundnut, jack bean and soybean isolates from *Bradyrhizobium* reference strains in this study suggests that Eswatini could be a hot spot for many novel species that are waiting to be taxonomically delineated.

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Keywords:

16S rRNA, DNA, ERIC-PCR, Housekeeping and symbiotic genes, N-fixing, Rhizobia

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1	Mr Hasten Aloy Alozie Osondu	Phytochemical Food Network Research group, Department of Crop Science, Tshwane University of Technology, Pretoria West Campus, Pretoria, South Africa

Introduction:

Anthracnose disease causes severe postharvest losses in avocado fruit (*Persea americana*) during the supply chain. Currently used Prochloraz® (fungicide) poses health and food safety risks to consumers. In this study, chitosan hydrochloride coatings were examined for their ability to control avocado fruit anthracnose and trigger defense mechanisms.

Materials and Methods

Trigger-ripe (commercially ripe stage) avocados (Fuerte cv) were inoculated preventatively with *Colletotrichum gloeosporioides* (106 spores /mL) and randomly distributed into seven treatments of three replicate boxes comprising of ten fruit each. Avocados were coated with 1.5% chitosan hydrochloride (CH), 0.7% vanillic acid (VA), 0.7% Caffeic acid (CA), CH and 0.7% VA (CH-VA), CH and CA (CH-CA). Prochloraz treatment and sterile water were used as controls. Inoculated fruits were incubated (28 days at 6.5 °C at 85% RH, and thereafter for 5 day at 20±2 °C, 75% RH). The incidence of anthracnose and the epicatechin content of the pericarp was determined on day 5. Coatings were characterized using UV-vis spectroscopy and FTIR. The effect of treatments on the expression of Chalcone synthase (CHS), phenylalanine ammonia lyase (PAL), lipoxygenase (LOX), fatty acid elongase (avael) and desaturase (avfadl 2-3) genes were determined using the RT-qPCR (Bill et al. 2017).

Results and Discussion

The loading of Chitosan hydrochloride with functional compound (FC) was established by observed absorption at 290 nm (CH-VA) and CH-CA at 290 to 350 nm in the UV-vis spectra while the FTIR confirmed a chemical interaction by the vibrational stretch relative to the standalone treatments (CH, VA and CA). CH-CA and CH-VA had no anthracnose disease incidence compared to all other treatments. CH-VA and CH-CA coating up-regulated the PAL, CHS, Avfael and Avfadl 2-3 genes and down regulated LOX with a concomitant significant increase in skin epicatechin, relative to the control.

Conclusion

CH-CA and CH-VA coating controlled anthracnose incidences, by triggering the up-regulation of fruit defense genes in *C. gloeosporioides* infected avocados. Therefore, CH-VA and CH-CA coating can be used to effectively control anthracnose in avocado fruits. These coatings could be further investigated in other fruits.

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Keywords:

Colletotrichum gloeosporioides, edible coating, phenylpropanoid pathway, phytochemicals, postharvest decay, subtropical fruit

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Author(s)

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Introduction:

The ARC-TSC has shown that macadamia kernel quality is affected by storage duration and temperature, kernel style and time of year harvesting occurs. The latter is counter-intuitive since most nuts are harvested from the ground within 10-14 days of abscising from the tree, with little difference between late and early season nuts in tree-to-packing time. However, early and late abscising nuts tend to be of different cultivars. Furthermore, late season kernel has higher oil content than early season kernel for the same cultivar. This gives rise to the hypothesis that:

1. Different cultivars may have different fatty acid profiles
2. Late season nuts may accumulate oils with different fatty acid profiles to early season nuts.

Materials and Methods

Nuts were harvested from trees of various cultivars over the duration of a season. Regional factors were accounted for by collecting nuts of the same cultivar from sites from the KZN coast through to the Limpopo production area. Nuts were dehusked, cured (35°C) and shelled by hand. Kernel was floated to remove immature kernels and dried at (60°C). Oil was cold pressed from the kernels and analysed for peroxide value (Pv), free fatty acids (FFA), induced oxidation time (Rancimat method) and fatty acid profiles.

Results and Discussion

Significant differences were found in fatty acid profiles and the ratio of saturated to unsaturated fatty acids, both between cultivars and within individual cultivars, over time. This suggests that some cultivars have potential to be marketed as high oleic or high palmitoleic macadamias – both of these fatty acids having potential health benefits. Using the Rancimat test as a proxy for shelf life, it was shown that there are considerable differences between cultivars in terms of their potential shelf life. However, there was no single factor which accounted for these differences. The highest correlations in terms of shelf life were between induction time and cis-Linoleic acid ($r^2 = 0.2338$) and between induction time and polyunsaturated fatty acids ($r^2 = 0.2331$). There was a strong correlation between Pv and induction time ($r^2 = 0.8528$), indicating that Pv is a good predictor of shelf life.

Conclusion

Fatty acid profiles differ significantly between macadamia cultivars and also change as the season progresses. There appears to be no single fatty acid which affects shelf life, with the possible exception of cis-linoleic acid. Pv is a good indicator of potential shelf life. Some cultivars may be “more nutritious” than others, opening the way for single-cultivar marketing.

Keywords:

Macadamia, fatty acid, quality, shelf life, cultivar

THE EFFECT OF TIMING OF APPLICATION AND DOSAGE OF CLOPROP ON FRUIT ENLARGEMENT AND CLOPROP RESIDUES IN QUEEN PINEAPPLE FRUIT AT HARVEST.

Oral

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Introduction:

Cloprop is used as a fruit enlarger in Queen pineapple production. It is applied twice - at dead petal stage and one week later. No minimum residue level (MRL) is set for cloprop and therefore the default MRL of 0.01 is used for all fruit to be exported. With the current registration of 2 000 ml per hectare, a much higher residue level is found. Even dosages as low as 1000 ml per hectare still resulted in too high residue levels in the fruit. Trials were therefore done to determine if application of lower dosages earlier in the fruit growth stage or growing season will give acceptable residue levels in the fruit.

Materials and Methods

Dosages varying from 400 ml/ha to 2 000 ml/ha were applied in different combinations at 25 days after flower induction, dead petal stage and dead petal stage plus 7 days. Eight treatments replicated three times were applied in a randomized block design. Fruit width and length were measured in field as well as at harvest to determine the increase in fruit size. Yield as ton/hectare was determined for each treatment. Residues of cloprop were determined at harvest.

Results and Discussion

All treatments gave an increase in fruit length, width and average fruit mass at harvest. Increase in fruit width was greater than increase in fruit length. No significant differences were found for yield between the dosages applied early in the season. However, yield of the early applications was slightly lower than the yield from the later applications. Only the 400 ml/ha application gave a lower yield when applied later in the season. In the early applications the 800 ml/ha application had fruit with residue levels above the limit, whilst the 400 ml/ha and 1000 ml/ha applications had no fruit above the limit. The higher dosages (1000 ml/ha, 2000 ml/ha) of the later applications had all residue levels above the limit.

Conclusion

The early application of cloprop gave a slight reduction (1 t/ha) in yield, but with a lower risk of residues. It can therefore be applied where a market require fruit within the MRL of 0.01.

Keywords:

Ananas comosus, minimum residue level, cloprop dosage, dead petal stage

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Introduction:

Natural flowering is a severe problem in the production of Queen pineapple in South Africa. It is mainly induced during the winter months June to August, but smaller peaks in natural flowering can also occur during other months of the year. Previous trials showed that Aviglycine applied at 800g/ha every 2 weeks from June to August can provide up to 98% control of natural flowering depending on plant size and the occurrence of other stress factors such as drought (Rabie et.al, 2011, 2013). This treatment though is very expensive and therefore, the effect of treatment combinations of aviglycine, cloprop, rhamnolipids and fertilizers were investigated as cheaper alternatives for the control of natural flowering.

Materials and Methods

A trial was conducted to determine the effect of a rhamnolipid biosurfactant on the efficacy of a reduced dosage of aviglycine and cloprop, as well as the effect of aviglycine and cloprop in combination with fertilisers, on the occurrence of natural flowering. Aviglycine (400g, 600g and 800g per hectare), cloprop (300ml and 500 ml/ha) and the fertilizer combination of ammonium sulphate (25kg/ha), urea (100kg/ha) and magnesium sulphate (25 kg/ha) were applied alone or in combination. The rhamnolipid biosurfactant were added to the lower dosages of aviglycine and cloprop. Treatments were applied every 2 weeks (6 times) during June to August. Nine treatments were replicated 3 times in a randomized block design.

Results and Discussion

It was found that all treatments gave a significant reduction in the occurrence of natural flowering. The rhamnolipid biosurfactants increased the efficacy of aviglycine but treatments where fertilisers were applied had a higher incidence of black spot in the fruit. Cloprop, in combination with fertilisers, gave good control as an alternative, but had the negative result of poorer fruit quality in the induced crop.

Conclusion

Results from this trial indicate that cheaper alternatives for aviglycine for the control of natural flowering in Queen pineapple are available and can be applied with success. Rhamnolipid biosurfactants increase the efficacy of aviglycine and a lower dosage can be applied with the same percentage reduction in natural flowering.

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Keywords:

Ananas comosus, fruit quality, black spot, ammonium sulphate, urea, magnesium sulphate, biosurfactant,

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Introduction:

Bush tea (*Athrixia phyllicoides* DC.) is one of herbal teas which contains bioactive compounds. Most of these metabolites assist plants in defending themselves against wide spectrum of biotic and abiotic stressors. One of the unusual abiotic stressors of plants is light (especially ultraviolet light). Naturally, plants use light for basic biochemical processes such as photosynthesis. Due to excessive light associated with climatic changes, plants are constantly deploying old and new strategies to circumvent the effect thereof. Some phenolic compounds (such as flavonoids) have been shown to help plants against high ultraviolet (UV)-light exposure. The main objective of the study was to identify possible metabolites affected by UV light exposure of bush tea through liquid chromatography mass spectrometry (LC-MS).

Materials and Methods

The experiment was laid out in a randomized complete block design consisting of the control and white 80% shade net and analyzed in triplicates. The methanolic leaf extracts of bush tea were also exposed to UV light at 254 nm for 24 hours and metabolites which formed due to UV exposure were measured and annotated through LC-MS.

Results and Discussion

Hydroxyl-cinnamic acid (HCAs) derivatives have been shown to undergo photo-isomerization during post UV light exposure, evidenced by the emergence of photo-isomers. The findings showed the cinnamic acid- containing molecules to undergo photo-chemical isomerization characterized mainly by the formation of molecules with cis geometry. The metabolites which underwent photo-isomerization were found to be structurally related as they formed a very tight molecular family when molecular networking algorithm was used.

Conclusion

Bush tea uses hydroxyl-cinnamic acid-containing molecules to adapt to against excessive UV light exposure by induction of photo-isomerization processes. Furthermore, the biological consequence of these molecule are unknown but changes in their physical-chemical properties such as polarity could influence the bioavailability of the phenolic consortium of this plant. The future prospects of the study are to investigate the molecular network of bush tea grown under different types of shade net.

Keywords:

Athrixia phyllicoides, hydroxyl-cinnamic acid, isomerization, liquid chromatography mass spectrometry (LC-MS), UV light, secondary metabolites.

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Introduction:

In South Africa onions are regarded as an economically important crop, however, low yields in many parts of the country are due to poor soil fertility management. Nitrogen is one of the most important factors affecting onion yield. Hence, the present study was undertaken to evaluate the effect of different nitrogenous (N) fertilizers on growth, yield, quality, and nitrogen use efficiency of short-day onions (*Allium cepa* L.).

Materials and Methods

A two-year field experiment was conducted at Hygrotech farm, in Moloto, Kwamhlanga to determine the effects of combined application of different nitrogen fertilizers on onion growth, biomass yield, and fresh bulb yield. Six nitrogen sources (urea, limestone ammonium nitrate (LAN), calcium-cyanamide, calcium-cyanamide+ urea, calcium-cyanamide+ LAN, and control (no fertilizer) were replicated six times in a Randomized Complete Block Design. According to the recommendations, calcium-cyanamide blocks should be 400 kg/ha N, LAN blocks should be 130 kg/ha N and urea blocks should be 130 kg/ha N. GLM Procedure in SAS software was used to analyse variance according to the experimental design for each year separately.

Results and Discussion

Treatment effects on biomass, economic yield, and nitrogen use efficiency (NUE) were highly significant ($p > 0.001$) and its interaction with year (nitrogen source x year) did not have any influence. The use of calcium-cyanamide resulted in an increase in plant height of 4 and 2.5% compared to urea and LAN, and 14% over control. The addition of calcium-cyanamide to urea and LAN further increased plant height by 5 and 4% respectively over urea and LAN and by 15% over control. Combined application fertilization of calcium-cyanamide to urea and LAN increased the average bulb weight by 4.7 and 5.2%, total dry biomass by 10 and 11%, harvest index by about 6 and 4%, total bulb yield by 3.04 and 3.28 t/ha-1 and marketable bulb yield by 4.17 and 4.15 t/ha-1 over urea and LAN. By combining calcium-cyanamide with urea and LAN fertilization, the crop increased its nitrogen use efficiency by 25 and 30% and the NUE increased by 19 and 22% respectively.

Conclusion

Both biomass, economic yield and NUE of short-day onion were highly affected by the combined fertilization application. In this study, optimum economic yield and highest NUE was achieved when calcium-cyanamide was combined with limestone ammonium nitrate. Adding calcium-cyanamide to both urea and LAN enhanced the growth of onion plant and resulted in optimum fresh total and economic bulb yield and high plant NUE.

Keywords:

nitrogen, yield, quality, nitrogen use efficiency

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2	Ms Maanea L. Ramphinwa	Department of Plant and Soil Sciences, Faculty of Science, Engineering and Agriculture, University of Venda, Thohoyandou, South Africa.

Introduction:

The use of indigenous tea has, in recent years gained popularity due to its medicinal properties with health benefits. As a result, they have become widely studied focusing on increasing yield for commercialization and maintaining secondary metabolites of indigenous herbal teas. Bush tea is an indigenous shrub in South Africa used as herbal tea greatly treasured in folklore medicine. Considering the need to rationalize bush tea commercialization, it is important to determine the cost-effectiveness of organic nutrient sources as an alternative to conventional fertilizers. Currently, there is insufficient information on the growth and biochemical responses of bush tea to organic nutrient management. Thus, the study was conducted to determine the influences of conventional slow-release and organic/manure nutritional management on physiological and metabolomic attributes of bush tea; with the main intention to identify acceptable standards as benchmarks in organic bush tea production. The study will generate information about the best production method of bush tea about fertilizer application to promote growth and maintain the metabolites quality which in turn preserve the environment.

Materials and Methods

The experiment was conducted at the University of Venda as a factorial arrangement in a randomized complete block design constituting of Bush tea plants with ten treatment of different types of nutrient sources with three replicates. Treatments consisted of conventional and organic fertilizers, namely LAN, Kelpak, Potassium chloride, Multicote, Gromer Super Sulphate, Petro Urea, Green Sulphur, Chicken manure, Kraal manure, and control. Plant height, chlorophyll content, intercepted radiation, fresh and dry weight were collected for physiological parameters. Harvested leaves of bush tea were subjected to LC-MS for analysis of secondary metabolites and data analyzed via XCMS.

Results and Discussion

The preliminary results indicate that different types of fertilizers significantly affected the fresh and dry mass, chlorophyll content, plant height, and the secondary metabolites in bush tea. LAN and Kraal manure had the highest fresh and dry weight with Kelpak having the lowest fresh and dry mass. PCA scores plot indicated the significance of class discrimination and revealed varied responses of metabolites to different treatments.

Conclusion

The results indicated that bush tea physiological parameters and metabolites responded differently to various fertilizer treatments. Kraal manure and chicken manure will be assessed for mineral content analysis to validate the nutrient content.

Keywords:

Athrixia phyllicoides, organic fertilizers, liquid chromatography mass spectrometry (LC-MS), secondary metabolites.

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2	Dr Tendekai Mahlanza	Agricultural Research Council – Plant Health and Protection (ARC-PHP), Plant Virology Unit, Pretoria, South Africa
3	Prof Augustine Gubba	University of KwaZulu-Natal (UKZN), Discipline of Plant Pathology, Pietermaritzburg, South Africa
4	Dr Anna E.C. Jooste	Agricultural Research Council - Tropical and Subtropical Crops (ARC-TSC), Crop Protection Division, Mbombela, South Africa

Introduction:

Banana bunchy top disease (BBTD) caused by banana bunchy top virus is one of the most economically important diseases of bananas (Jebakumar et al., 2018). BBTV is transmitted through infected planting material and by *Pentalonia nigronervosa* (Hemiptera: Aphididae). Plant species, *Colocasia esculenta* (taro), *Alocasia esculenta* (elephant's ear), *Alpinia zerumbet* (shell ginger) and *Strelitzia reginae* (bird of paradise), that are usually found growing around banana plantations, were investigated to determine if these plants act as reservoirs of the virus vector, the banana aphid, in South Africa. Furthermore, the study sought to determine if these plants are potential hosts of BBTV.

Materials and Methods

A transmission study was done using a BBTV infected and uninfected aphid colony. Twenty aphids were transferred to six plants of each of the plant species mentioned above using a fine brush; three replications from the infected colony and three from the uninfected colony. *Musa* spp. were included as positive and negative controls. The trial was monitored for 88 days post-inoculation and data on the rate of aphid colonization and BBTV symptom expression were recorded at weeks 5, 9 and 12 of the trial. A qPCR (Chen and Hu, 2013) was optimised to test for BBTV on plant and aphid material) at each interval. In addition, alternative host plants (*Canna indica*, *C. esculenta* and *S. reginae*) growing in close proximity of BBTV symptomatic plants were sampled.

Results and Discussion

Aphid numbers declined on *S. reginae*, *A. esculenta* and *C. esculenta* to the point that there were no aphids on these plants by week 5 while aphids established on *A. zerumbet* and *Musa* spp, being present until the trial was terminated. From BBTV transmission studies, none of the other plant species tested positive for BBTV, besides *Musa* spp, at the end of the trial following qPCR assays. Furthermore, BBTV was not detected on *C. indica*, *C. esculenta* and *S. reginae* plants found growing in close proximity to BBTV-infected banana plantations. There were also no sign of aphid colonies on these plant species.

Conclusion

These findings therefore suggest that, other than *Musa* and *A. zerumbet* spp., the alternative host plants tested in this study are not potential hosts of *P. nigronervosa* and BBTV in South Africa. The results from this study contribute towards understanding the epidemiological implications of alternative host plants in banana plantations. Therefore, scouting for aphids on these alternative hosts can be implemented as a precautionary measure to mitigate the risk of potential BBTV transmission.

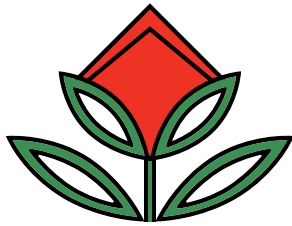
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Keywords:

Alternative Hosts, Transmission Study, Banana bunchy top virus, Banana aphid, virus-vector relationships, aphid colonization.



COMBINED CONGRESS

Annual congress of
SSSSA, SASHS & SASCP

Abstracts

Poster presentations:
Horticultural Science
(SASHS)

Presenter: Mary Maphoto (leeannmaphoto@gmail.com)

Author(s)

#	Name	Affiliation
1	Mary Maphoto	Combined congress

Introduction:

Chili (*Capsicum frutescens* L.) is an important crop from the family of Solanaceae. Plant nutrition remains one of the most important factors responsible for enhancing growth, development and yield in vegetable crops (Leghari et al. 2015). Amongst all the nutrients, nitrogen is the most important in chili because it is required in high quantities and can hinder crop growth and yield (Suryakumari et al. 2014). The aim of the study was to investigate the effect of nitrogen and plant density on the growth and yield of Chili cultivars.

Materials and Methods

A 3×3×2 factorial study arranged in randomized complete block design, replicated three times was conducted at the Agricultural Research Council-Vegetable, Pretoria in October -April (2017-2018 and 2018- 2019). Two chili pepper cultivars (Bataleur & Malaga) were subjected to three plant densities (111 111; 66 667 and 41 667 p/ha) and three N application levels (100, 150 and 200 Kg/ha). There were 54 unit plots in the experiment in total, which accommodated 28, 25 and 20 plants at the spacing 30 cm × 30 cm; 30 cm × 50 cm; 30 cm × 80 cm respectively. The nitrogen level of 100 N/ha was applied in three applications of 34 kg N/ha, 150 N/ha was applied in three applications of 50 kg N/ha and 200 N/ha was applied in three applications of 66 kg N/ha during planting, after 14 days and after 30 days of transplanting. Plant height, leaf area index, chlorophyll content, number of branches, number of leaves, number of fruits and number of flowers were recorded biweekly. Drip irrigation was used with a one-day interval for two hours to irrigate the plants.

Results and Discussion

Malaga had taller plants (91.89 cm), longest and biggest fruits (11.65 and 4.02 cm) as compared to Bataleur. The interaction of nitrogen, cultivar and planting density had a significant impact on the fruit yield of Malaga and Bataleur cultivars ($P \leq 0.00$). Planting density of 111 111 p/ha produced 5.4 t/ha Bataleur and 4.2 t/ha Malaga. There was a significant difference in the nitrogen levels on yield ($P \leq 0.05$). the yield of 5.2 t/ha (Bataleur) and 4.0 t/ha (Malaga) was observed from 200N kg/ha,

Conclusion

Based on the findings from this study, 200N kg/ha and 111 111p/ha are recommended for the cultivation of chili. Bataleur cultivar is recommended for cultivation in Pretoria, Gauteng since it performed better than Malaga in terms of yield.

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Keywords:

Chili cultivar, growth, Nitrogen, Planting density, yield

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4	Lerato Kgotse	University of Mpumalanga, Private Bag X11283, Mbombela, 1200, South Africa.
5	Nezelo Mlombo	University of Mpumalanga, Private Bag X11283, Mbombela, 1200, South Africa.
6	Moses Timana	University of Mpumalanga, Private Bag X11283, Mbombela, 1200, South Africa.
7	Nicholas Mnyambo	University of Mpumalanga, Private Bag X11283, Mbombela, 1200, South Africa.
8	Lambert Letsoalo	University of Mpumalanga, Private Bag X11283, Mbombela, 1200, South Africa.
9	Zakheleni Dube	University of Mpumalanga, Private Bag X11283, Mbombela, 1200, South Africa.
10	Confidence Muzerengi	University of Mpumalanga, Private Bag X11283, Mbombela, 1200, South Africa.

Introduction:

Cancer bush is a widely recognized medicinally important perennial legume that is native in the Southern Africa (Fernandes et al., 2004). It holds many pharmacological effects because of the active compounds present in it. Dormancy is the main problem preventing sustainable use of medicinal plants that are able to germinate in their native arid land but fail to reveal good germination under laboratory conditions or when cultivation is attempted on field (Canter et al., 2005). According to Shaik et al. (2008) several efforts made to germinate *Surthelandia* in a wide range of soils led to poor germination, not more than 10%. The objective of the study was therefore to determine the mechanism of dormancy in Cancer Bush (*Sutherlandia frutescens*).

Materials and Methods

The experiment was carried out at the University of Mpumalanga to determine the germination response of cancer bush when treated with different pre-sowing treatments and develop means to break seed dormancy. Treatments were scarification with sand paper for 10s, H₂SO₄ (concentrations of 40, 60, 100% for 2, 4, 6 min), hot water treatment (60, 80 and 100°C for 2, 4, 6 min), cold water (0, 24, 48, 72 and 96 h), NaCl (0, 2, 4 and 6g L⁻¹ for 24, 48, 72 and 96 h) and lastly with *Trichoderma harzianum* (3, 6, 12 and 24 h).

Results and Discussion

Scarification of *Sutherlandia frutescens* had the best of all techniques with 100% germination within two days after exposure. Exposure of seeds to hot water treatment at 80°C for 2 and 4min were also effective in improving germination of cancer bush giving 70 and 60% germination, respectively. All other techniques gave less than 20% germination.

Conclusion

Among all the various treatments, exposing cancer bush seeds to hot water treatment and scarification will be good for field establishment and also producing uniform plant population.

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Keywords:

Cancer bush, Cultivation, Dormancy, Germination, Medicinal plants, Priming

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3	Vimbaniashie Edina Manhivi	Co-supervisor At Phytochemical Food Network Group Department of Crop Sciences, Tshwane University of Technology, Private Bag X680, Pretoria, 0001
4	Dharini Sivakumar.	Supervisor At Phytochemical Food Network Group Department of Crop Sciences, Tshwane University of Technology, Private Bag X680, Pretoria, 0001

Introduction:

Microgreens are young, tender greens that are used to enhance the colour, texture, and garnish a wide variety of main dishes. Plants with a plant height of 2.5 to 8 cm, depending on the species, are considered microgreens and have greater nutritional value than mature plants (Xiao et al., 2012). To meet consumer's high demand for microgreens, it is imperative to improve their shelf life. It has been proven that light-emitting diode (LED) lights on retail or storage shelves improve the nutritional value and shelf life of horticulture products. In the present study, the effects of different LED lights were examined on the quality and antioxidant activity of postharvest radish microgreens during storage at 5°C and 85% RH for 6 days.

Materials and Methods

Radish (*Raphanus sativus*) seeds were sown in seedling trays filled with growing medium (TS1) at a density of 12 seeds per cavity. After the 14th day of planting, microgreens were harvested, packaged in commercial PET (polyethylene terephthalate) containers (500 g, 14,0cm x 11,5cm x 3,8cm), and exposed to different LED lights [red (660 nm), far red (720 nm), blue (450 nm) and white light (white cool fluorescent lamps; Phillips, Fluotone 40 W) (control), with 12 replications per treatment], for 6 days at 5°C and at 85%RH. Microgreens exposed to white light and stored in continuous darkness were regarded as controls. After withdrawal from cold storage the percentage weight loss, colour change, ascorbic acid content, and antioxidant scavenging activity DPPH of radish microgreens were determined under ANOVA statistical test.

Results and Discussion

There was no significant difference in the changes in colour parameters (ΔE) after radish microgreens were exposed to all the light treatments during the display. Compared to all other light treatments, red LED light significantly increased the value of ascorbic acid (vitamin C) and DPPH scavenging activity in radish microgreens at 6 days of display. Microgreens exposed to red, far-red, and blue LED lights showed commercially acceptable levels of weight loss, but those exposed to white LED lights lost more than 10% of their weight, and reduced the acceptability to consumers. The red LED light could have activated the ascorbate biosynthetic pathway, increasing ascorbic acid content, leading to an increase in antioxidant scavenging activity.

Conclusion

Installing red LED lights in display shelves at 5°C and 85% RH can help to maintain the salable weight, colour, ascorbic acid content, and antioxidant activity to benefit the consumer's preference and accessibility to quality microgreens.

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Keywords:

Radish Microgreen, LED lights, Storage,

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Author(s)

#	Name	Affiliation
1	Ms Makhosazana Shange	Department of Agriculture, Rural Development, Land and Environmental Affairs, Nooitgedacht Agricultural Development Centre, Private Bag X9019 Ermelo 2351
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Introduction:

Sweet potato (*Ipomoea batatas* L.) is a plant grown for its edible tuberous roots in tropical, subtropical and warm-temperate regions. It is a starch crop with a high potential to meet the food and nutrition security needs. This tuber is grown for its hardiness and tolerance to climatic shocks, it tend to possess characteristics adaptable to adverse abiotic and biotic stress conditions. These conditions are predicted to become even more prevalent in the coming decades as a result of the effects of climate change. This study seeks to review the food security features of a sweet potato.

Materials and Methods

Literature review was used as a method to integrate findings and perspectives from the previous studies that were conducted on sweet potato, and its potential as a food security crop.

Results and Discussion

Improving yield production and stability under stressful conditions is necessary to fulfil the food demand of the ever-growing world population. Sweet potato is one crop that has a wide ecological adaptation, because of its tolerance to a wide range of agro-ecological conditions, high yield potential, ease of cultivation, effective vegetative propagation and high nutritive value, the sweet potato is suitable for growth on marginal lands. It can also be harvested sequentially, thus ensuring continuous food availability and access, an important dimension of food security. According to reports from previous studies, it is possible to produce sweet potato crop and have it available all year round in the tropical and subtropical areas of South Africa where warm conditions prevail, even if drought is a challenge for staple crops such as cereals. It is believed that the availability of varieties with improved yield, taste and adaptation to low input conditions will facilitate sustainable sweet potato production in South Africa, thereby contributing to food security.

Conclusion

From the perspective of food security, sweet potato is more resilient than other staple food crops. Sweet potato has the potential to combat increasing food shortages as it provides high yield in terms of edible energy per unit area. It is a hardy crop that has relatively low demands on soil nutrients, while also being more drought tolerant than many other vegetables. For all these reasons sweet potato have great possibilities for enhancing food and nutrition security in developing countries. Farmer participatory research projects are crucial to create awareness about the importance of sweet potato and its value as food security crop.

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Keywords:

Climate change, food security, sweet potato

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2	Dr. GM Coetzer	Study leader at the University of the Free State Department Soil, Crop and Climate Sciences
3	Dr. C Schmidt	Kynoch Fertilizer Co-Study leader

Introduction:

Numerous researchers have studied the importance of zinc in the production of pecan nuts. Zinc influences the pecan tree physiology and nut quality. Calcareous and alkali soils in the main pecan nut producing regions of the Northern Cape (South Africa), limit the availability of zinc in soil. Foliar application of zinc has become mandatory in pecan production to ensure higher quality yields.

There are many zinc carriers available on the market, making it difficult for pecan nut producers as to which zinc carrier is the most efficient in alleviating zinc deficiencies. The objective of this study was to determine the influence of four different foliar applied zinc (zinc sulphate, zinc nitrate, Zn-EDTA and a zinc-amino acid complexed) carriers on the growth, physiology, quality and yield quality of pecan nuts.

Materials and Methods

Zinc carriers were applied at three concentrations (0.5, 1.0 and 1.5%) and two application times (early and late season) in a pot trial with two-year-old 'Wichita' pecan trees. This was done to evaluate the absorption efficiency of the different carriers; the effect of carriers on carbohydrate- and protein metabolism and the effect of carriers on chlorophyll production and photosynthesis. Zinc carriers and concentrations were duplicated (applied in 5 sprays over the growing season) in a field trial with 5-year-old 'Wichita' pecan trees to evaluate the effect of zinc carriers on nut yield and quality.

Results and Discussion

Leaf zinc- and protein content increased after both early and late season zinc sprays. There was however no significant difference between the different applied zinc carriers. Carotene content of leaves was increased by the early season zinc foliar spray, with no significant difference between the different zinc carriers. The nut yield per tree, nut size and kernel percentage for the field trial did not significantly differ between the different applied zinc carriers. The results show that zinc has an clear influence on the pecan tree physiology.

Conclusion

Data obtained from the study shows that the application of zinc is more important than the specific carrier of zinc used. Producers can consequently apply the most cost-effective carrier limiting the cost of foliar zinc applications.

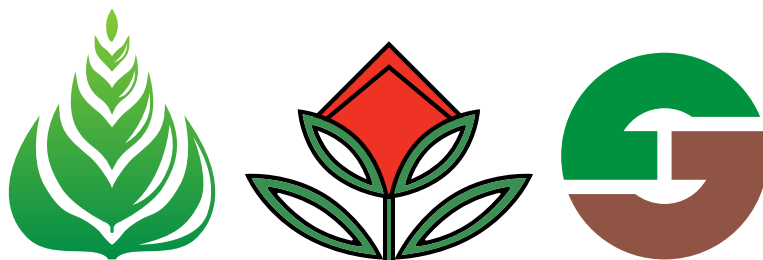
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SPARKS, D., 1976. Zinc nutrition and the pecan a review. Pecan South 39(3): 14-22.

Keywords:

zinc carrier, pecan, absorption, physiology, foliar



COMBINED CONGRESS

Annual congress of
SSSSA, SASHS & SASCP

Abstracts

Oral presentations:
Soil Science
(SSSSA)

Presenter: Nyasha Chiuta (nyashachiuta@gmail.com)

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3	Prof Phatu Mashela	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Department of Plant Production, Soil Science and Agricultural Engineering
2	Dr Kgabo Pofu	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Department of Plant Production, Soil Science and Agricultural Engineering

Introduction:

Root-knot (*Meloidogyne* species) nematodes are a major yield- and quality-reducing pest in most potato (*Solanum tuberosum* L.) producing regions in South Africa (Onkendi and Moleleki, 2013). The sustainable production of potato depends on the inclusion of nematode resistance crops in sequential cropping systems. The objective of this study was to investigate the efficacy of pre- and post-infectious nematode resistant crops on managing root-knot nematodes in potato-based cropping sequences.

Materials and Methods

The studies were conducted at University of Limpopo and Agricultural Research Council under field conditions from 2017 to 2019. The treatment crops, namely, sweet stem sorghum cv. 'Ndendane-X1' (*Sorghum bicolor*), *Cucumis africanus*, potato cv. 'Mondial G3' and potato cv. 'Mondial G3'-velum (control), were randomly assigned to 2 m × 2 m subplots in Sequence 1. The treatments were laid out in a randomised complete block design, replicated six times. Sole potato cultivation was done in Sequence 2. Crop arrangement in Sequence 3 and 4 was as in Sequence 1 and 2, respectively. At 56 days after emergence of potato, nematodes were sampled and extracted from roots and soil. Tubers were harvested to determine the marketable tuber yield. The nematode data were subjected to non-parametric Friedman test using the XLSTAT 2019 software, whereas the tuber yield data were subjected to ANOVA using the Statistix 10.0 software. The treatment means of nematode and tuber yield data were compared at the probability level of 5% using the Nemenyi test and Fischer's Least Significance Difference test, respectively.

Results and Discussion

Generally, post-infectious resistant *C. africanus* crop was more effective than pre-infectious resistant sorghum or potato monoculture cropping sequence in reducing *Meloidogyne* species population densities in the soil. Additionally, damage to subsequent potato crop in *C. africanus*-potato cropping sequence was significantly reduced as shown by high marketable tuber yield at both locations. Conversely, the pre-infectious nematode resistant sorghum crops appeared to protect themselves against nematode damage, but not the subsequent susceptible potato crop.

Conclusion

The inclusion of post-infectious nematode resistant crops such as *C. africanus* in potato production was a good option for managing root-knot nematode damage under field conditions.

References

Onkendi EM, Moleleki LN. 2013. Distribution and genetic diversity of root-knot nematodes (*Meloidogyne* spp.) in potatoes from South Africa. *Plant Pathology* 62:1184–1192.

Keywords:

cropping sequence, *Cucumis africanus*, marketable tuber yield, root-knot nematodes, sorghum

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2	Dr George Munnik van Zijl	Senior lecturer at the North-West University, Department of Natural and Agricultural Sciences, School of Geo-and Spatial Sciences, Unit of Environmental Sciences.
3	Prof Klaus Kellner	Senior lecturer at the North-West University, Department of Natural and Agricultural Sciences, School of Biological Sciences, Unit of Botany.

Introduction:

Bush encroachment is a serious form of land degradation and South Africa alone has lost an estimated 8 million hectares (ha) of grazing or cultivation land due to bush encroachment. Only a few previous studies included soil as a possible cause for bush encroachment. This study aimed to determine whether soil was a driving factor of bush encroachment in the North West Province between 1993 and 2018.

To reach the aim, the following objectives had to be met:

- Identify the main driving factors of bush encroachment in the study area for the specified period.
- Make recommendations regarding the management of bush encroachment represented by certain soil types.

Materials and Methods

Maps indicating the percentage (%) of woody cover for the years 1993, 1998, and 2018 were sourced from Symeonakis et al. (2020) and was used for calculating the spread of bush (bush encroachment, bush thickening, and bush lessening) for time frames, 1993-1998, 1998-2018 and 1993-2018. Potential driving factors of bush encroachment, which included: topography, mean annual temperature (MAT) and mean annual precipitation (MAP), land-use, soil types, vegetation, and geology were selected and GIS were used to analyse the bush spread and determine the driving factor/s of each bush spread from 1993 to 2018 on a provincial scale. Four smaller areas were identified based on the significant spread of bush and the same GIS analyses were done for determining the driving factor/s of each bush spread from 1993 to 2018.

Results and Discussion

On a provincial scale, bush encroachment showed slight correlations with land-use, while bush thickening showed significant correlations with MAP. The smaller areas with severe bush encroachment and bush thickening both showed a significant correlation with soil types. Low MAP, together with overgrazing in these areas likely decreased the grass cover, and with deep soils, allowed woody seedlings to obtain nutrients, outcompete grass and establish, while established woody vegetation were able to develop in bush thickets.

Conclusion

On a provincial scale, land-use and MAP were important driving factors, while in communally-managed areas, land-use and MAP together with soil types, were important driving factors of bush encroachment from 1993 to 2018. Therefore, soil can be regarded as a minor driving factor of bush encroachment in the North West Province. Community-managed areas that are predominantly comprised of deep, sandy soils should be regarded as "potential encroaching zones" and manual, biological and, if possible, chemical control methods should be implemented to prevent or restrict bush encroachment.

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Keywords:

Bush encroachment, bush thickening, GIS, land-use, North West Province, soil.

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Introduction:

Worldwide urbanization increases rapidly and if this trend persists urban landcover will increase with 1.2 million km² by 2030. With this rapid urbanization, infrastructure development is essential to meet everybody's needs. When developing infrastructure, the area's hydrology needs to be considered, as the hydrology influences the infrastructure and the infrastructure changes the area's hydrology. Therefore, firstly understanding the hydrology is important, to enable sustainable environmental management. Knowing how the soils and hydrology will interact is important for understanding the hydrology, and therefore a soil map is needed. Conventional methods for soil mapping of urban areas usually are difficult and costly, requiring innovative solutions, like Digital Soil Mapping (DSM). In this project, a hydopedological digital soil map was created for three quaternary catchments (630km²) of the Jukskei river in the greater Johannesburg area, using DSM and legacy soil data. Two different machine learning algorithms will be used, with three different approaches to determine training and validation datasets.

Materials and Methods

Legacy soil profile data was obtained and combined into a single dataset. The 519 datapoints was divided into the appropriate hydopedological classes and an environmental covariates database was compiled from STRM 30m digital elevation model, satellite imagery, the land type survey, climatic- and geological maps. The datasets were standardized to the same 30m grid. The soil profile dataset was divided into a training and evaluation dataset, using three different methods. Multinomial logistic regression (MNLr) and random forests (RF) machine learning algorithms were then applied to the different training datasets and created six different soil maps. The one-pixel buffer method was then used acceptability evaluation of the map, using the different evaluation datasets.

Results and Discussion

The stratified random sampling showed the highest accuracy for both algorithms. The RF algorithm consistently outperformed the MNLr algorithm in terms of accuracy but excluded some map units. This indicates overfitting, deeming the RF created maps not acceptable. The stratified random sampling with the MNLr method generated the highest accuracy map (Kappa value of 0.64). This map adequately expresses the reality of the soil spatial variation within the study area.

Conclusion

DSM proved to be useful in mapping the Jukskei river catchment. The MNLr method proved to be the best prediction method, because it includes all the soil map units. The stratified random sampling was the better sampling method compared to the other. Therefore it was clear that using stratified random sampling with the MNLr method, generated the most acceptable hydopedological soil map.

Keywords:

Johannesburg, Hydopedology, Sampling, Random Forests, Multinomial Logistic Regression

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Introduction:

Food insecurity remains a key challenge in sub-Saharan Africa (SSA), where the number of undernourished people exceeds 200 million and food production is currently below demand despite a growing population. SSA still relies on rain-fed agriculture which makes it vulnerable to climate variability and extreme events such as droughts and flooding. Projected increases in warming and increasingly uncertain rainfall patterns coupled with land degradation present a bleak future for food and nutrition security. Modelling alone cannot represent the complexity and cross-scale nature of food systems. Addressing these challenges requires a systems-thinking approach that accounts for the different components of the food system, combining expert knowledge with integrated modelling.

This study sought to advance integrated assessment modelling in four countries in SSA – Malawi, South Africa, Tanzania, and Zambia, and to identify the implications of different policy pathways for crop production and soil health, which are central to building and maintaining resilient food systems.

Materials and Methods

This was achieved by applying a unique assessment framework known as the integrated Future Estimator for Emissions and Diets (iFEED), which involved: 1) participatory stakeholder workshops to define possible future scenarios, 2) modelling of crop production, greenhouse gas emissions, trade and nutrition, soil erosion, and extreme weather events, and 3) integration of expert knowledge with model outputs. Here, we focus on the results of this integration process, expanding upon model results to provide implication statements aimed at informing policies at national and regional scales, and guiding local land management activities.

Field-based studies on the impacts of farmers' climate-smart agricultural (CSA) practices such as conservation agriculture and cropping systems on soil health indicators and crop productivity, provided results used in the iFEED integration process.

Results and Discussion

Soil degradation (especially in the form of water erosion) is expected to increase with increasing rainfall intensity, leading to significant reduction in crop production. Cropping systems are currently vulnerable to climate stress and farmers are at risk from slow crop breeding and varietal replacement cycles. Conservation agriculture and other climate-smart soil and water conservation practices show potential for improving soil health and particularly soil structure, which is vital for increasing the resilience of the agro-ecosystem to environmental stress.

Conclusion

Proactive climate-smart soil management practices and crop diversification combined with irrigation and the use of improved crop varieties are key to building resilient and sustainable agricultural and food systems in SSA.

Keywords:

Food security, climate change, crop diversification, sustainable agriculture, sub-Saharan Africa, soil health

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Introduction:

Cotton production in South Africa has declined over the past decades. The decline in production is mainly due to uncertainties on the soil water consumption of the cotton. Soil water management has therefore become crucial to ensure sustainability. The study hypothesizes that different soil forms will have different soil water regimes and retention capabilities, and as a result have different effects on the cotton yield and quality.

Materials and Methods

Four dominant soil forms were identified in each of the cotton fields and assessed over a 2-year period. The soil water was measured once monthly on each of the soil forms with a neutron probe. Undisturbed core samples were extracted from each of the different soil forms and analyzed with a pressure plate system to obtain the lower limit (LL) and drained upper limit (DUL) to calculate the amount of plant-available water and the dry bulk density per soil horizon. The cotton quality was determined by random sampling of cotton bolls at each of the different soil form measurement sites and analyzed with the HVI system to obtain the cotton quality parameters.

Results and Discussion

Sandy clay soils such as the Westleigh, Tukulu, and Sepane soil water content were observed to be notably above DUL throughout the production season, while the sandy clay loam soils such as the Avalon's soil water content tend to be above DUL for a short period. When the soil water content is above DUL oxygen stress may occur in the crop. The effect of the water table and fallowing in the area was observed through more soil water being available post-season than pre-season. Soil depth profiles indicated soil water accumulation post-season on the plinthic and gleyic limiting layers. Sandy clay soils such as the Westleigh and Tukulu produced better quality cotton and higher micronaire cotton fibers than sandy clay loam soils such as the Avalon or Bainsvlei soil forms, even with the soil water conditions being above DUL. Sandy clay loam soils such as the Avalon and Bainsvlei delivered the highest cotton yield of lower quality compared to the sandy clay soils.

Conclusion

It is evident that soil forms vary in terms of soil water regimes and the amount of soil water available throughout the production season. This variation does influence the production in terms of cotton quality and yield. By quantifying the effect of the soil forms on the soil water content, sustainable cotton production can be expanded in the future.

References

Keywords:

Neutron probe, undisturbed core samples, drained upper limit, lower limit, cotton quality, sustainable agriculture

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Introduction:

The soil is a self-sustaining living organism with vast numbers of diverse microbes. Several biotic and abiotic factors affect the structure of the rhizospheric microbial community. These can include soil characteristics, land use history, plant species and plant genotype as well as stage of development. Arguably, the most important single factor that shapes the rhizosphere community is the soil characteristics. The factors in the soil that shape the microbial community include the physical and chemical traits, moisture, nutrient availability, and pH (Schlemper, T.R. et al. 2017).

Materials and Methods

Reference soil samples of a turf and sandy soil were taken from two farms, near Bela Bela in Limpopo province and Reitz in the Free State, respectively. The samples were taken as reference samples for the carbon losses and gains trial at ARC.

Results and Discussion

The microbial community composition varied for two cultivation practices which were Conservation Agriculture (CA) and Conventional Cultivation (CC). Veld samples were used as the reference for the base line samples. NGS analysis revealed the presence of 708 Genera for the six composite samples, of which an average of 54% could not be identified. Of the remaining 344 genera identified, a literature search revealed that 54 bacterial genera demonstrated functionality relevant to agricultural soils. These included nitrification, carbon cycling and decomposition, chemoheterotrophs, PCB (polychlorinated biphenyls) and xenobiotic decomposers, as well as phosphorus cycling microbes. The number of microbes with the ability to metabolise PCBs and xenobiotics is also encouraging, as agricultural soils frequently require remediation after introduction of foreign chemicals, such as herbicides and insecticides.

Conclusion

In conclusion, although the number of organisms whose functionality could be identified was limited, it was encouraging to see the diversity. The soil type had an influence on the community make-up. The soils that are disturbed, as with ploughing and discing, show variation in the microbial community. Example Bradyrhizobium, a nitrogen fixer, was dominant in the sandy Reitz, CA soil followed by the Veld. The microbial community in the Bela Bela turf CC and CA soils, was almost similar due the short period of adjustment from no-till to discing.

References

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Keywords:

Functionality, Rhizosphere, Soil microbial community, Cultivation practice

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Introduction:

Precision agriculture (PA) has been named as a cultivation method which could help alleviate food shortages in the future. However, PA relies on knowing the spatial distribution of soil properties, which requires repeated, quick, accurate, and cost-effective soil analysis. Conventional methods of soil analysis are slow and costly, reducing the application of PA in South Africa. Soil spectroscopy can fulfil the need for quick cost-effective soil analysis, but depend on robust calibration curves, of which none exist openly for South Africa. It is expected that mid-infrared soil spectroscopy can be used to analyse soil samples for soil properties pH, Effective CEC and P within the Western Highveld summer grain area.

Materials and Methods

Data for this study was provided by NWK and GWK which resulted in a selection pool of $\pm 5\,180$ samples already analysed for soil properties. Conditioned Latin Hypercube sampling (cLHS) was then used to select 1 000 samples based on the pH, Effective CEC and P values of the dataset. The samples were then prepared and scanned with Mid Infrared ($4\,000\text{ cm}^{-1}$ to 400 cm^{-1}) using a Bruker Alpha II with DRIFTS module attached to create a spectral library. The soil property database and spectral library was combined and the R programming language was used to create calibration models using Cubist, Partial Least Square regression (PLSR) and Random Forest (RF). Each calibration algorithm was also applied onto two types of spectral datasets which includes spectra with pre-processing and spectra with minimal to no pre-processing applied. These models were validated using statistical performance measures including root mean square error (RMSE), squared correlation coefficient (r^2), standard deviation, bias and ratio of performance to deviation (RPD).

Results and Discussion

Results show that models created for pH with Cubist and pre-processed spectral data had the best performance ($R^2=0.86$, RMSE=0.3, RPD=2.66) along with effective CEC with Cubist ($R^2=0.86$, RMSE=0.3, RPD=2.66) and RF ($R^2=0.85$, RMSE=0.72) and then P with some success using PLSR ($R^2=0.51$, RMSE=14.55) and P with RF ($R^2=0.57$, RMSE=13.48, RPD=1.51). Overall performance increase was observed with Cubist, PLSR and RF models using pre-processed spectral data compared to spectra with no pre-processing and produced an acceptable calibration model to be able to predict P from soil spectra.

Conclusion

Findings are consistent with other studies conducted worldwide but with little to no data to compare from South Africa more research and data is needed to create models that include all soil properties used for PA and that is representative of the whole of South Africa.

References

Keywords:

Precision Agriculture, Mid-Infrared, soil spectroscopy, Cubist, Random forest, Partial least square regression

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Introduction:

In developing countries, like South Africa, most people in rural areas rely on untreated groundwater drinking sources (Rosa and Clasen, 2010) and pit latrine sanitations (DWAF, 2010; Stats SA'S GHS, 2017). Biochar has a high potential in wastewater management to reduce heavy metal movements. An understanding of the biochar structure through characterization is important for its proper uses. This study evaluated and characterize pinewood biochar and determined the retention and migration of heavy metals (Ag, Cd, Cu, Pb and Zn) using replica pit latrine soil bed leaching columns.

Materials and Methods

Pinewood biochar was characterized by physico-chemical and structural methods (N₂ adsorption methods, DFT, BET surface area, differential pore volume and distribution). Forty-eight packed soil-bed leaching columns were carried out for sorption characteristics of Ag, Cd, Cu, Pb and Zn on biochar. The experiment had 3 treatment application rates for biochar (equivalent to 5, 10, 20 ton ha⁻¹) and 3 leaching concentrations treatments (5, 7, 10 mg. L⁻¹ of Ag, Cd, Cu, Pb and Zn).

Results and Discussion

The biochar had an alkaline pH, C composition of 92 % and surface area of 517.20 m²/g and pore size of 1.7 nm. At a relative pressure of 0.9 p/p₀ the DFT adsorption isotherms increased both adsorption and desorption to 145 cm³/g. The differential and pore size distribution had the highest pore volume of 0.165 cm³/g. Å. The maximum adsorption capacity for the biochar achieved was 21 mg.g⁻¹ at 20 ton ha⁻¹. The adsorption studies for removal of the metal ions from solution had a high rate between 60 – 96 % for Ag, Pb and Zn. Lower removal rates below 60 % were seen for Cd and Cu. The fitted adsorption experimental data was well described by the Langmuir adsorption isotherm model (R², 0.993 to 1) than the Freundlich models (R², 0.769 to 0.918).

Conclusion

The results suggest that the pinewood biochar can be effective in improving wastewater and soil contaminates immobilization to protect water resources.

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Keywords:

Biochar; Characterization; Heavy metals; Soil-bed columns; Adsorption isotherms; Water resource quality

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Introduction:

Monitoring soil quality is an essential practice for agriculture and environmental protection. One form of soil quality degradation to monitor is soil salinization. Soil salinity is a worldwide problem especially in arid and semi-arid regions. Identifying areas that are affected by soil salinity is a crucial step in practicing sustainable land management. The objective of this study was to determine soil surface salt accumulation with acceptable accuracy from remote sensing images. It is hypothesized that remote sensing images will enable accurate determination of soil surface salt accumulation.

Materials and Methods

The study was conducted in Syferkuil, experimental farm of the University of Limpopo. A grid sampling of 50 m by 50 m was followed to collect 55 soil samples. Global positioning system (GPS) was used to record the exact location of each sampled point in each grid. The electrical conductivity (EC) of the soil samples was determined conventionally in the laboratory using Mettler Toledo EC meter following the method from Jones (2001).

A multispectral image with more than 10 bands ranging from the visible to shortwave infrared was used to predict the soil EC. The coordinates of the sampling points were used to extract spectral value from the image. The spectral values and the conventionally determined soil EC were modelled using partial least square regression (PLSR). The performance of the model prediction was measured using the coefficient of determination (R^2) and root mean square error (RMSE).

Results and Discussion

The PLSR model yielded the RMSE of 0.44 and the R^2 of 0.468. The result shows that the reflectance values as recoded in the image could explain approximately half of the EC variation. The deviation of the predicted values from the measured was minimal as indicated by the low RMSE value. The low R^2 value indicates that there are confounding factors. The confounding factors might come in the form of noise and errors due to variations in soil surface roughness, geometric and atmospheric effects (Casa et al., 2013). Furthermore, the performance of models might be because of low spectral resolution of the image as compared to hyperspectral data, which have bands with narrow wavelengths (Qi et al., 2017).

Conclusion

Although the performance of the model was not excellent. Sentinel 2 could be used to make preliminary study of EC before detailed in situ assessment could be done. Thus, it is recommended that an image with better spectral resolution (hyperspectral) be investigated to see if the model's performance improves.

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Keywords:

Multispectral (sentinel 2) imagery, PLSR, Remote sensing, Soil quality, Soil salinity, Sustainable land management , and Syferkuil farm.

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Introduction:

Mines are responsible for significant environmental damage that can lead to soil erosion and destruction of agricultural land. Mining companies are thus legally required to progressively rehabilitate land disturbed by mining activities with the intention of returning the land to some degree of its former state. To comply, the mining sector constantly seek to improve the standards of mine-site rehabilitation. The research reported here investigated an enzyme-based soil alteration index (AI3), which quantifies the balance between the activities of constituent soil enzymes β -glucosidase, acid-phosphatase and urease. The AI3 and its constituent enzymes potentially enable differences in soil health, between progressive stages of rehabilitation, to be quantified in relative terms.

Materials and Methods

Soil samples were collected twice, in April 2019 and June 2020, from PPC De Hoek mine in Piketberg, Western Cape, South Africa (32° 56' 30.18" S, 18° 45' 28.98" E). The treatments were: Un-rehabilitated mined soil, 1-year rehabilitated mined soil, 10-year rehabilitated mined soil and a Control (adjacent farm soil). Composite soil samples, comprising of ten sub samples each, were obtained from top- (0-15cm) and subsoil (15-30cm) layers. β -glucosidase, phosphatase and urease activities were used to calculate AI3 scores, using the formula and coefficients developed by Puglisi et al. (2006).

Results and Discussion

Soil health gradually improved at progressive stages of rehabilitation, generally in the sequence Un-rehabilitated mined soil > 1-year rehabilitated mined soil > 10-year rehabilitated mined soil > Adjacent farm soil, suggesting that rehabilitation is successful. Occasionally, the 10-year rehabilitated mined soil exhibited soil health similar to that of the adjacent farm soil, suggesting a return of the land to some degree of its former state. Also, better soil health in top- than subsoil layers were observed, which is attributable to gradients in mineralizable substrates, reflected by the higher enzyme activity levels and AI3 index scores in top- than subsoils across the treatments and seasons. AI3 and constituent enzymes also correlated with soil nutrient status.

Conclusion

Individual enzyme activities and the AI3 were able to show gradual improvement in soil health at progressive stages of mine rehabilitation. Thus, this approach potentially lends itself to wide application as a monitoring tool for mine soil rehabilitation assessment.

References

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Keywords:

AI3 index, mine rehabilitation, soil enzymes, soil health

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Introduction:

Pre-harvest burning of sugarcane (burnt cane) for easier harvesting and concentrating sucrose content, may reduce soil quality and increase carbon dioxide concentrations in the atmosphere, contributing to global warming and climate change. Harvesting without pre-burning (green cane) retains large quantities of biomass on the surface which may be an alternative to improve carbon sequestration and microbial activity in soil. However, there is paucity of information on these effects, where sugarcane is produced on highly weathered, acidic soils containing naturally high concentrations of organic matter (humic soils) in South Africa. Therefore, in the current study, we examined the effects of green cane relative to burnt cane on soil organic carbon (SOC) content and its fractions, microbial biomass carbon (SMB-C) and β -glucosidase enzyme activity in humic soils.

Materials and Methods

Soils under green cane (two fields) were compared with the one under burnt cane adjacent to one of the green cane fields. Replicate soil samples were collected at different depths from four different slope positions. The SOC and its fractions were determined using Walkley-Black dichromate oxidation method. Soil MBC was determined using chloroform fumigation-extraction method. Enzyme β -glucosidase activity was assayed using the substrate p-nitrophenol- β -D-Glucopyranoside.

Results and Discussion

The SOC was significantly higher in green cane 1 and 2 (adjacent to burnt cane) than burnt cane, by 27% and 24%, respectively. The unprotected coarse particulate OC was the primary C storage fraction under all managements, contributed > 50% of the total OC. The concentration of SOC decreased with increased in soil depth, but remained >1.8% to 100 and 80 cm depth in the green cane and burnt cane fields, respectively. The SMB-C was higher in both green cane fields than burnt cane. The β -glucosidase activity under both green cane fields was significantly higher than burnt cane in top layers (0-20 cm), but decreased with increase in soil depth for both managements. The higher SOC, SMB-C, and β -glucosidase in green cane than burnt cane could be explained by the addition of residues which increases biomass addition.

Conclusion

The study showed that green cane production increases soil OC storage and microbial activity, with potential reduction in greenhouse gas emission and sustainable sugarcane production when compared with burnt cane on humic soils. These findings can make significant contribution for policy on sustainable sugarcane production in view of climate change.

Keywords:

Burnt cane, carbon, β -glucosidase, green cane, microbial biomass

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Introduction:

Low crop yields under smallholder agriculture may be attributed to poor soil fertility and available soil water content during the growing period. Soil organic amendments and mulching is recommended to manage soil fertility and water stress. Application of poultry litter in combination with mulch has not been widely investigated in Vhembe district.

Materials and Methods

A study was conducted to determine the effect of mulching and poultry litter on selected soil properties (bulk density, soil porosity, soil organic carbon), and sunflower grain yield . All these soil properties were determined before planting and at harvesting. Bulk density was determined by core ring sampler, organic carbon with Walkley black method, soil porosity was determined using indirect measurement where bulk density results used with particle density to calculate porosity whilst grain yield was determined by weighing dried mass of sunflower seeds from 21 plants over the area of 6 m². The study was conducted for two summer seasons of 2019/2020 and 2020/2021 at University of Venda Experimental Farm. The experiment was laid out as a completely randomized block design (CRBD) with 3 replications. Plot sizes measured 4x4m were used to plant sunflower crop. Poultry litter collected from chicken houses at the farm was incorporated to a depth of 0-20 cm into the soil before being applied at 3 rates (0, 6.25 tons/ha, 10 tons/ha) whilst straw mulch was applied on the soil surface 14 days after emergence at 3 rates (0, 2.5 tons/ha, 5 ton/ha).

Results and Discussion

Application of poultry litter and mulch significantly increased organic carbon at 0-20 cm depth. Interaction of poultry litter with straw mulch recorded highest organic carbon (2.05%) in the first season, and second season with (1.28%). Combination of poultry litter and straw mulch decreased bulk density in both seasons. The decrease of bulk density resulted in increased soil porosity. Combination treatment non-significantly increased grain yield with highest grain yield recoded under 2.5 tons/ha of straw mulch and 6.25 tons/ha of poultry litter, lowest yield was recorded under 2.5tons/ha of straw mulch only.

Conclusion

These results indicated that the combined treatment of poultry litter and straw mulch significantly increased soil organic carbon whilst decreasing bulk density. Straw mulch increased sunflower growth performance and eventually the grain yield

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Keywords:

poultry litter, soil properties, straw mulching, sunflower

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Introduction:

Functional services of soil quality support crop production and answer to its sustainability and renewability (Usman and Kundiri, 2016). Soil quality deterioration negatively impacts South African soils and crop production (Dlamini and Chaplot, 2016). This study involved the use of under explored legumes in South Africa under maize-legume intercropping systems as a strategy to improve and conserve soil physicochemical properties.

Materials and Methods

The study comprised of five treatments which were laid out in a split plot design at two locations, Syferkuil and Univen. Treatments included: sole maize (SM), sole chickpea (SC), sole mungbean (SMB), maize-chickpea (MC) and maize-mungbean (MMB) intercropping systems under two water regimes. The experiments were terminated after maturity stage. Pre- and post-soil samples were collected and analysed for the following bio-physicochemical parameters: soil bulk density (BD), aggregate stability (AS), pH, Soil pH, electrical conductivity (EC), organic carbon (OC), phosphorus (P), ammonium-nitrogen (NH₄), nitrate-nitrogen (NO₃), organic matter (OM), active carbon (SAC), and potentially mineralizable nitrogen (PMN). Data was analysed using split plot ANOVA at p-level of 5% using GenStat software.

Results and Discussion

Significant differences ($p < 0.05$) were observed only in chemical (pH, EC, OC, NH₄, NO₃) and biological properties (OM, SAC, PMN) at both locations, except for P at Syferkuil. The legumes did not affect soil physical properties (BD and AS) at Syferkuil whereas significant difference was observed on AS at Univen. The study showed a rise in soil pH and EC at Syferkuil which could be attributed to borehole water used for irrigation, as it was reported by Kgopa et al. (2017) that the water is saline. Furthermore, improvement in soil biological and chemical parameters (OC, NH₄, OM, P) was observed in legume pure stands and intercrops, with pure stands showing the highest improvement as compared to maize pure stands.

Conclusion

The findings showed some conservation and restoration of some important mineral nutrients with the use of legumes, which notably showed high improvement in nutrient content. Therefore, it is recommended that legume intercropping approach to soil quality restoration be adopted as a low-cost technology strategy towards sustainable crop production

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Keywords:

Soil quality, Intercropping, physicochemical

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Introduction:

Interactions between fire and herbivore grazing are crucial for maintaining the co-existence of trees and grasses and controlling woody plant encroachment in savanna grasslands. The interactive effects of fire and herbivore grazing on soil carbon (C) and nutrient dynamics in savannas remain poorly understood, yet soil C storage and nutrient availability influences the patterns and processes governing grass productivity and tree species distribution in these ecosystems.

Materials and Methods

Soil samples were collected in the topsoil layer of frequently late burnt and wildlife grazed (LB+G) plots and unburnt plots at the Kruger National Park (KNP). The collected samples were analyzed for soil carbon, nitrogen (N), exchangeable magnesium (Mg), calcium (Ca), potassium (K) and micronutrients; manganese (Mn), copper (Cu) and zinc (Zn).

Results and Discussion

We found that 7-years of frequent burning and herbivore grazing altered soil C and nutrients in a savanna grassland at KNP. Specifically, total C and N were 24% and 30% lower in the LB+G plots compared to the control. The decrease in C and N content led to slightly higher soil C:N ratio in the LB+G plots. Depletion of C and N in the LB+G plots was attributed to disturbance of soil by frequent burning and herbivore grazing, which removes aboveground biomass and reduces C inputs and storage. Results further showed that exchangeable magnesium (Mg) increased by 25%, while there was a 15% decrease in exchangeable calcium (Ca) in the LB+G plots compared to the control. The increase in Mg is linked to the deposition of urine and dung by the grazing wildlife, whereas, reduction of Ca is a consequence of physical removal of nutrient-containing ash by erosion and gaseous losses during combustion leading to its loss to the atmosphere as calcium oxide (CaO). Moreover, micro-nutrients; manganese (Mn) and copper (Cu) increased by 27% and 29%, respectively in the LB+G plots. Deposition of ash after burning contributed to the incorporation of Mn and Cu into the soil surface. The accrual of Mn and Cu in the soil is caused by the enrichment of Cu and Mn oxides emanating from the ash material.

Conclusion

It can be concluded that 7 years of frequent burning and herbivore grazing of a savanna grassland at KNP decreased C and N content in the soil, with variable effects on exchangeable cations and micronutrients.

References

Keywords:

Frequent burning, herbivore grazing, soil nutrients, carbon, savanna grasslands

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Introduction:

While conservation agriculture (CA) has largely been successful in many areas, some reports suggest that certain farmers have not realized the benefits they hoped for, especially in Africa (Findlay, 2015; Lal, 2019). Realizing the benefit of CA could depend on the cropping sequences involved. Cropping sequence effects on soil organic carbon (SOC) and nutrient dynamics in CA systems are not always well understood. This study determined the short-term effects of wheat (*Triticum aestivum* L.) /maize (*Zea mays* L.) and wheat/soybean (*Glycine max* L.) cropping sequences on fractions of SOC and inorganic phosphorus and other soil quality parameters on CA farms.

Materials and Methods

The study was conducted on irrigated wheat-based CA farms where wheat was rotated with either soybean or maize in the KwaZulu-Natal (KZN) province, South Africa. Soil samples were collected from the 0-200 and 200-400 mm depths during winter wheat planting time in 2017. The samples were analyzed for total nitrogen (N), SOC, inorganic phosphorus (P), pH, exchangeable acidity (EA), exchangeable potassium (K), calcium (Ca) and magnesium (Mg), extractable zinc (Zn) and copper (Cu). Cation exchange capacity (CEC), and total C stocks were calculated. Data were subjected to a non-parametric Kruskal Wallis H statistical test, Mann-Whitney post hoc test and Spearman's correlation at a 95% confidence level on GenStat (18th edition).

Results and Discussion

Soil pH and concentrations of labile P (NaHCO_3 Pi), exchangeable K, Ca, Mg and CEC were significantly higher while NaOH I Pi, acid saturation, and Ca:Mg were lower in maize/wheat than soybean/wheat sequences. The SOC stocks and concentrations and total N did not vary significantly with cropping sequences, possibly because > 94% of SOC was associated with the mineral fraction, thus protected against decomposition. Concentrations of SOC, extractable P, NaHCO_3 P, exchangeable K, and Zn were significantly ($p < 0.05$) higher in the 0-200 than 200-400 mm soil depth. Cropping sequences did not significantly affect NaOH II Pi, residual P and Cu. Extractable P had significant positive correlations with particulate organic carbon fractions.

Conclusion

In overall, cropping sequences in the wheat-based CA systems have limited short-term influence on SOC stocks and concentrations of its fractions but the maize/wheat sequence had higher soil pH, labile P and exchangeable K. The findings imply that the short-term effects of cropping sequence on SOC sequestration are limited while wheat crops preceded by maize could benefit from the higher soil pH, labile P and K in these CA systems.

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Keywords:

cropping sequence, carbon fractions, maize, nutrient availability, phosphorus fractions, soybean.

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Introduction:

Silicon (Si) is considered a beneficial element in sugarcane production and many studies report strong responses to Si amendments (Camargo and Keeping 2021). While local studies also report improved yield and reduced pest incidence, the magnitude of responses are often smaller than reported elsewhere (Berry et al. 2011, Keeping et al. 2013). Currently no clear guidelines to ameliorate deficiencies are available and growers remain sceptical of the benefits of applying amendments, particularly in relation to cost of application. This study uses a meta-analytic approach to examine the responses of sugarcane to Si application under field conditions, with the aim of better understanding the magnitude and direction of those responses.

Materials and Methods

Thirty-three field studies representing 135 plant and 106 ratoon responses were identified for use in the meta-analysis. Sucrose yield (TS/ha) and 3rd leaf Si concentrations (%) were compared between Si-treated and control treatments (no Si applied) using a precision weighted mean difference approach. Sub-group analysis was used to explore effects of some of the treatment factors. Data were analysed using the open-source software package OPENMEE based on the Metafor R-core package (<http://www.cebm.brown.edu/openmee/>).

Results and Discussion

The overall sucrose yield response was significantly positive (plant: 1.26 ± 0.3 ; ratoon: 0.93 ± 0.3 TS/ha). South African studies had poorer, but significant, positive responses (plant: 0.34 ± 0.2 ; ratoon: 0.56 ± 0.3). Sucrose yield increased in plants crops as Si application rate increased, but responses were inconsistent in the ratoon crops. Broadcast and incorporated Si amendments gave the best response in planting, with residual effects observed in the subsequent ratoon crops. Furrow and top-dressed Si amendments were less effective. Slags were the most commonly used Si-amendment, which reflected in the overall better responses from these of these products. Overall leaf Si% response (plant and ratoon combined) was 0.22 ± 0.02 , while that from local studies was only 0.05 ± 0.02 . Plant crops responded better than ratoons, while incorporation and higher rates improved Si uptake. There was no clear relationship between leaf Si and sucrose yield.

Conclusion

While some studies report large responses to Si amendments, local studies suggest that additional factors are limiting Si uptake. Evidence indicates that higher rates may be required at planting to ensure adequate Si supply. Very strong responses to Si application on Florida's organic soils suggest that a mechanism to blend Si with organic materials before application may enhance root access and uptake of Si. Further investigations will examine soil properties (where reported) as factors in responses.

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Keywords:

Meta-analysis, silicon, slag, sugarcane

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Introduction:

Conservation agriculture (CA) is production system that involves three principles which are minimal or zero tillage, crop rotation and mulching with crop residues. However, there are relatively few studies that have documented the benefits of CA on soil physical properties of vertisols. A study was carried out to determine the effect of conservation agriculture on soil bulk density, soil water holding capacity, soil organic carbon and soil electrical conductivity. The study was conducted at Tshivhilwi village.

Materials and Methods

Soil samples were collected from a field under CA and NG (control). Soil samples were collected from two different depths (0-10 and 10-20 cm) along the transects which were at, 10 m apart. Soil organic carbon was determined using the modified Walkley-Black wet oxidation procedure. Soil water holding capacity was determined by saturating with water a known weight of oven-dried soil in a glass funnel and allowed free drainage for 48hrs after which the weight of moist soil was measured and its water holding capacity determined by gravimetric method. Core method was used to determine soil bulk density.

Results and Discussion

There was a significant difference ($p \leq 0.05$) in selected soil physical properties on CA at both soil depths (0-10 and 10-20 cm). soil organic carbon content was significantly affected by management practices. CA site show high content of SOC compare to natural grassland, addition of crop residues and less soil erosion due to cover of soil and minimal tillage contributed to high content of SOC. Bulk density was higher on natural grassland than CA which recorded a bulk density of 0.8 g/cm³. It was observed that CA has a better soil qualities which lead to a better bulk density. High percentage of available organic matter at top soil layer lead to lower bulk density. In contrast soil water holding capacity was significantly higher on CA site which recorded a WHC of 10.48mm/cm at 0-10cm soil depth. CA practices increase SOC and alter pore size which improve soil WHC. However only top soil layer has a high percentage of SOC which limit the increase capacity of WHC in the whole soil profile.

Conclusion

Based on the results, conservation agriculture system improved soil physical properties.

Keywords:

Conservation agriculture, Physical properties, Vertisol, natural grassland,

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Introduction:

Conservation agriculture (CA) is gaining popularity because of the potential for C sequestration and beneficial effects on soil fertility, nutrient cycling and crop performance. Minimum soil disturbance as one of the principles of CA might however cause stratification of, amongst others, soil organic C. Currently little is known regarding the extent of organic C stratification under CA in the grain producing areas of the Western Cape. The aim of this study was to quantify C stratification on two typical soils.

Materials and Methods

The research was conducted on existing long-term trials (started in 2007) at Langgewens (Moorreesburg) and Tygerhoek (Riviersonderend). Four tillage treatments formed part of the study, namely:

1. Zero-till(ZT) – soil left undisturbed and planted with a disc planter
2. No-till (NT) – soil left undisturbed until planting and then planted with a no-till tine planter,
3. Minimum till (MT)– soil scarified to depth of ± 100 -150 mm early autumn
4. Conventional tillage (CT) – soil scarified early autumn to a depth of ± 100 - 150 mm then ploughed to a depth of ± 200 mm.

Degree of soil disturbance increased from ZT to CT. Soil samples were collected in 0-5, 5-10, 10-15, 15-20 and 20-30 cm depth increments and bulked per depth. Organic C was determined using the Walkley Black method.

Results and Discussion

At Tygerhoek, the organic C content decreased with depth, irrespective of tillage treatment, although not always significantly so. The least disturbed, ZT treatment, had significantly higher C (2.6%) in the 0-5 cm depth and as the degree of soil disturbance increased, the C content decreased (NT 2.23%; MT 2.15% and CT 1.96%). Stratification was more severe between the 0-5 cm and 5-10 cm layer in ZT (37%) compared to NT (15%), MT (19%) and CT (11%) at Tygerhoek. The sharp decrease in C between ZT 0-5 cm and 5-10 cm is the result of little soil disturbance by the discs during the planting process.

Despite lower C contents at Langgewens the influence of the tillage treatments on the soil organic C was similar to those observed at Tygerhoek.

Conclusion

The study at both sites proved that decreasing soil disturbance definitely increased the stratification of organic C. This creates a better environment for the microbial populations due to improvements in soil aggregation, soil moisture and more favourable soil temperature. Microorganisms play a key role in the decomposition of organic residues and thus in cycling of N, S and P.

Keywords:

Conservation agriculture, soil carbon, stratification

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Introduction:

Hydropedology assessments are regularly requested for new developments in South Africa. The soil survey required for these assessments have different needs than conventional agriculture based surveys. This paper determined how these needs could be met at the various scales at which hydropedological assessments are conducted.

Materials and Methods

For each assessment scale, (i.e. point, hillslope and catchment) a case study of a commercial project done around South Africa was scrutinized as to how the soil surveys for the hydropedological assessments were done, and how the surveys differed from conventional surveys in terms of survey layout and methodology. For the point scale, various soil profiles were used from different environmental settings, for the hillslope scale a case study from Mpumalanga, while at the catchment scale a case study from the north of Johannesburg proved insightful.

Results and Discussion

At point scale the observation for a hydropedological assessment varies only from a conventional survey in that the observation needs to go to the bedrock. No depth limit is entertained as valuable information can be missed if observations are too shallow. At the hillslope scale the hydropedological survey needs to accommodate a transect from the top of the hillslope to the bottom of it. From this hillslope a conceptual hydrological response model could be created. At the catchment scale a digital soil mapping approach is generally taken to map the area. Soil observations should be placed representative of the co-variates of the area. However, to accommodate the hillslope requirements of the hydropedological assessment, representative hillslopes rather than point locations are selected. The representativeness of these locations could be tested with the p test and represented graphically with qq-plots.

Conclusion

At various scales hydropedological soil surveys differ from conventional ones. At point scale, the soil observation must reach to bedrock to sufficiently describe hydropedological processes. At hillslope scale the observations should represent a transect from top to bottom of the hillslope to identify dominant hillslope hydrological flowpaths, while at catchment scale representative hillslopes should be selected with representative sampling techniques generally used in digital soil mapping, in order for hydropedological interpretations to be made

Keywords:

Digital soil mapping, Johannesburg, cLHS, qq-plot, hydrological modelling

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Introduction:

Climate change will put millions people in Africa at risk of food and nutrition insecurity by 2050. As such, there is a need for holistic policies on agriculture, nutrition and trade to support sustainable, climate-resilient food systems. In order to make a more complete assessment of food system outcomes, an integrated assessment framework was developed incorporating models, data and expert judgment – the integrated Future Estimator for Emissions and Diets (iFEED). iFEED is a combination of information from stakeholder-driven scenario workshops, modelling, expert result evaluation and it provides key policy outcomes. The framework is applied in Malawi, Tanzania, Zambia and South Africa. Here, we focus on iFEED results for South Africa.

Materials and Methods

Based on the stakeholder workshops, four future scenarios were developed for the period to 2050, considering two key drivers of change to the future of the food system in South Africa: climate change risk and the extent of land reform. The integrated modelling involves cropland allocation assumptions (indicated by the stakeholders), climate-food-emissions modelling, and trade and nutrition analysis. Model outputs are summarized into calibrated statements with associated confidence assessments. The last stage of iFEED is then the integration of expert knowledge to supplement these modelling outcomes, using implication statements.

Results and Discussion

Results show that with high climate risk, production will increase due to increased actions to mitigate the climate risk, such as increased crop diversification and irrigation. There is great pressure on the soils under the high climate risk scenarios, with soils depleted of nutrients and loss of soil carbon, which needs to be counteracted with corresponding management. Under the limited land reform scenario, crop production increases marginally due to an assumed small increase in agricultural area. In all scenarios greenhouse gas emissions increase by approximately 50%. All modelled scenarios showed sufficient calories to provide food security; however, nutrition security did not improved, with supply of calcium and iron remaining to meet pollution needs. Nutrition security was only achieved by increasing the import of nutrient dense food commodities. The climate analysis showed an increased occurrence and frequency of temperature extremes by 2050, under both high and low climate risk.

Conclusion

Therefore, irrigation, crop diversification and new crop varieties are all key to maintaining and increasing crop yields and food production. Results show that an increase in imports of food commodities - or changes to domestic production to plug key nutrient gaps - will be required to achieve nutrition security by 2050.

Keywords:

CONCENTRATIONS AND FRACTIONS OF ORGANIC CARBON AND PHOSPHORUS AS AFFECTED BY PIG SLURRY APPLICATION ON OXIDIC SOILS UNDER SUBHUMID CONDITIONS

Oral

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Introduction:

Intensive pig production systems generate large volumes of slurry (PS), which is disposed of on agricultural land to improve soil organic carbon (SOC) and nutrient status. While this practice may lead to excessive accumulation of phosphorus (P), with detrimental environment effects, effects on SOC dynamics have shown contradictory results, while responses of soil P fractions are unclear. This study determined effects of successive application of PS on SOC and P and their fractions in a clayey Hutton under maize-soybean rotation in a subhumid subtropical climate

Materials and Methods

Soil for this study were sampled from the 0-10, 10-20 and 20-40 cm depths of a Hutton soil on fields amended with PS for 3-5 years and 20+ years, fields with no history of PS application as a control. Soil samples were analyzed for SOC, particulate organic carbon (POC) and mineral-associated organic carbon (MAOC), available P, and inorganic P fractions (soluble and loosely bound, Al-P, Fe-P, reductant soluble P, Ca-P) and total P.

Results and Discussion

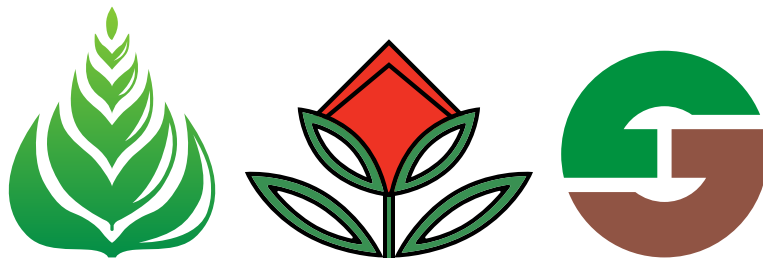
The PS application for 3-5 and 20+ years caused a decline in SOC and POC, with no effects on the MAOC compared to the control. Longer period of PS application (20+ years) caused greater decline in SOC and POC, when compared with 3-5 years. The decline of SOC and POC could be due to stimulation of microbial activity due to the supply labile C and nitrogen, causing the decomposition of native soil organic matter (priming effect). The PS application also increased total P, available P and Al-P and Fe-P fractions in the top 40 cm compared to the control. The increases could be explained by P from PS and mineral fertilizer some of which precipitated with soluble Al and Fe in the highly weathered soil.

Conclusion

Successive application of PS, under conventional tillage, causes rapid decline in SOC and POC and increase total and available P and the Al-P and Fe-P fractions, in highly weathered soils under subhumid climatic in the long-term. However, the PS application did not affect the MAOC, soluble and loosely bound P, and reductant soluble P. The findings imply that PS application under these conditions need to be monitored to avoid excessive loss of SOC and accumulation of P.

Keywords:

Pig slurry, organic carbon fractions, phosphorus fractions



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SSSSA, SASHS & SASCP

Abstracts

Poster presentations:
Soil Science
(SSSSA)

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2	Mr. CH Wessels	Agricultural Research Council - Natural Resources and Engineering, Private Bag X01, Glen, 9360

Introduction:

Maize biomass production and grain yields is low in rural areas of the Eastern Cape due to low rainfall and poor soil fertility. Soil management options (cover crops and mulch) can help increase maize yields, but there is limited information on how they can influence the yield when applied on in-field rainwater harvesting (IRWH) basins with bio-slurry as an organic fertilizer. This study therefore seeks to evaluate the effect of bio-slurry application method and rates in combination with various other soil management options (bare soil, cover crop and mulch) on maize growth and yield under field conditions.

Materials and Methods

A field experiment laid out as a randomized complete block design was conducted at the Fort Cox/Valsrivier ecotope (32.7450° S; 27.0268° E). The main plots were the different treatments (mulch, cover crop, manure and bare basin) with a spread or single bio-slurry application. The sub-plots were different bio-slurry application rates (0, 3, 5 and 7 t/ha). The experiment had a total of 20 treatments x concentration interactions, replicated four times. It was compared over four growing seasons (2016/2017 - 2019/2020) using maize (cultivar PAN 6R-680RR) as the indicator crop. Soil water content (SWC), biomass and grain yield were recorded and rainwater productivity (RWP) was calculated. Data was analyzed using Microsoft Excel to determine the 95% confidence interval differences between the various treatments.

Results and Discussion

Over the experimental period, the grain yields of individual treatments varied between 740 and 2251 kg/ha with a yield trend of mulch > cover crop > bare: bio-slurry incorporate > bare: bio-slurry surface application > bare: bio-slurry spread application > bare: water equivalent > manure. The same trend was followed for biomass and RWP. Bio-slurry normally helps to improve soil organic matter content and water-holding capacity, but the water contained in the bio-slurry was insufficient to significantly increase the SWC at planting, flowering and harvest.

Conclusion

Soil management options had a bigger impact on grain yield than the application of bio-slurry. Bio-slurry could provide a solution to expensive chemical fertilizers, but then it would need to be applied at much higher application rates. Bio-slurry application is not a viable option in communal croplands and can be used with much greater success in rural homestead gardens.

References

Keywords:

bio-slurry, in-field rainwater harvesting, maize, grain yield

PRELIMINARY RESULTS ON THE EFFICACY OF POLYACRYLAMIDE (PAM) TO ALLEVIATE SOIL CRUSTING FOR RECLAMATION OF DEGRADED LAND IN DINOKENG GAME RESERVE

Poster

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2	Dr Gerhardus P. Nortjé	University of South Africa
3	Prof Michiel C. Laker	University of South Africa

Introduction:

There is a serious, widespread problem of soil crusting in natural areas, especially in wildlife tourist areas within game reserves. Some of these areas with problem soil crusting, persisting for more than 40 years after formation (Laker and Nortjé, 2019) and has received little attention. It requires more research urgently.

The aim of this study is to evaluate the efficacy of selected ameliorants, including Polyacrylamide (PAM), to alleviate soil crusting and the eventual reclamation of degraded land. Preliminary qualitative results with PAM are reported here.

Materials and Methods

The experimental site is a large degraded area in Dinokeng Game Reserve near Pretoria. It is characterised by soil with an extremely hard, dense crust.

Three chemical soil ameliorants, including PAM at two application rates, are tested.

Ameliorants were applied to the soil surface in dry powder form. The soil was then wetted and a metal rake used to mix it into the top 1-2cm of soil, to create a crumb like surface.

The following measurements will be taken periodically: crust strength, structure stability, water infiltration, soil water content and the monitoring of the establishment of natural vegetation.

Results and Discussion

Qualitative observations revealed a very strong positive effect by PAM on this very problematic soil. During the wetting and crumbling of the soil surface, PAM immediately reacted and bound the soil in a crumb structure through a spider web glue like substance while the action was being performed. According to Green and Stott (1999), a drying cycle of the soil, increases the effectiveness of PAM. This was also observed at this site. After 17 mm rain the PAM treated soil maintained its crumb structure, unlike the other treatments where the crumb structure was lost. After passing of a herd of buffalo and an elephant the surface soil structure in the PAM treated plots persisted.

Conclusion

Preliminary visual observations are encouraging that PAM may be effective in the formation of a stable surface structure in a soil which is very prone to crusting. Quantitative verification of the structure stability will be done.

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Keywords:

Polyacrylamide, soil crusting.

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Introduction:

Biostimulants have been widely used in viticulture as a strategy to reduce the use of fertilizers, improve nutrition efficiency, grape growth, wine quality, water use efficiency and increase resistance to disease and abiotic stresses. These can only be accomplished by ensuring and maintaining quality standard products, which is possible only through proper scientific research and product validation. Studying the soil enzymes tied to microorganism processes may prove to be a significant step forward in understanding biostimulant functioning within a root-soil environment. Examining a soil alteration index (AI3), together with constituent enzymes β -glucosidase, urease and phosphatase, which are respectively involved in the cycling of the major plant nutrients C, N and P, was the primary focus of the current study.

Materials and Methods

Soil samples were collected over a two-year period (May 2019 and June 2020) from a table grape vineyard near Malmesbury, South Africa (33°40'S, 18°57'E). The experiment was a completely randomised design, with five treatments replicated four times. Five biostimulant products were applied with one untreated control. Soil samples were obtained from top- (0-15cm) and subsoil (15-30cm) layers. β -glucosidase, phosphatase and urease activities were used to calculate AI3 scores, using the formula and coefficients developed by Puglisi et al. (2006).

Results and Discussion

During each season as well as combined over both seasons, the Transformer (soil) + Ethepon biostimulant treatment was the only treatment that consistently performed better than the control in terms of the activities of the enzymes β -glucosidase and urease; with respect to AI3 index scores, it tended to perform better than the untreated control. This trend in regards to the treatment differences, was also evident in both the topsoil layers (0-15cm) and subsoil layers (15-30cm). Furthermore, better soil health in top- than subsoil layers were observed, which is attributable to gradients in mineralizable substrates, reflected by the higher enzyme activity levels and AI3 index scores in top- than subsoils across all the treatments and seasons.

Conclusion

The approach used in this research using enzyme activities and the AI3 potentially lends itself to application as a tool for assessing biostimulant functioning and performance in table grape vineyards. Further research is needed to substantiate the findings.

References

Puglisi E, Del Re AAM, Rao MA, Gianfreda L. 2006. Development and validation of numerical indices integrating enzyme activities of soils. *Soil Biology and Biochemistry* 38: 1673–1681.

Keywords:

AI3 index, biostimulant, soil enzymes, table grape, vineyard

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Introduction:

Biostimulants have great potential to improve soil fertility in viticulture. Efficacy of biostimulants nevertheless relies upon proper scientific research and product validation. This study explores a potential linkage between microbially-secreted soil enzymes and biostimulant functioning within the root-soil environment. Three enzymes β -glucosidase, urease and phosphatase, which are involved in the cycling of the major plant nutrients C, N and P, respectively, together with Alteration index three (AI3), which calculates the balances between these three enzymes, were investigated in a wine grape vineyard in the Western cape, South Africa.

Materials and Methods

Soil samples were collected over a two-year period (May 2019 and June 2020) from a wine grape vineyard near Klapmuts, South Africa (33°49'S, 18°54'E). The experiment was a completely randomised design, with five treatments replicated four times. Four biostimulant products were applied with one untreated control. Soil samples were obtained from top- (0-15cm) and subsoil (15-30cm) layers. The activities of β -glucosidase, phosphatase and urease were used to calculate AI3 scores, using the formula and coefficients developed by Puglisi et al. (2006).

Results and Discussion

Judging from the results obtained for each season as well as for the data combined over two seasons, there was a clear lack of differences amongst the biostimulant treatments. The untreated control did show a tendency to have had lower β -glucosidase and urease activities and AI3 scores compared to all the other treatments, which was observed only in the 15-30cm soil layer in the first season and when the data of the two seasons was combined. AI3 indices and individual enzyme activities further indicated better soil health in top- than subsoil layers, which is attributable to gradients in mineralizable substrates, reflected by the higher enzyme activity levels and AI3 index scores in top- than subsoils across all the treatments and seasons. A correlation between the AI3 and %C was also observed when the data was combined over two seasons, which agrees with previous findings.

Conclusion

The approach used in this research using enzyme activities and the AI3 potentially lends itself to application as a tool for assessing biostimulant functioning and performance in wine grape vineyards. More research is required to substantiate the findings.

References

Puglisi E, Del Re AAM, Rao MA, Gianfreda L. 2006. Development and validation of numerical indices integrating enzyme activities of soils. *Soil Biology and Biochemistry* 38: 1673–1681.

Keywords:

AI3 index, biostimulant, soil enzymes, wine grape, vineyard

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Introduction:

Phytoremediation is the green technology that uses green plants in association with microorganisms to clean up contaminated soils, including water bodies. However, the effects of remediation with different weeds on fertility status of the soil are not fully known. Therefore, this study was undertaken to investigate the effects of using different weeds for remediation on selected soil properties.

Materials and Methods

The study comprised of 28 pots with a volume of 20 cm³. The pots were filled with three (kg) of soil and contaminated with treated wastewater for a period of eight weeks. The study comprised of seven treatments, with four replications arranged in a complete randomized block design (CRBD). The treatments comprised of the following: Control (C0), *Cleome gynandra* L. (C1), *Conyza Canadensis* L. (C2), *Cucumis africanus* L. (C3), *Amaranthus retroflexus* (A), *Bidens pilosa* (B) and *Portulaca oleracea* (P).

The control of the study was a pot filled with soil without any weeds planted while receiving similar irrigation from treated wastewater. After the contamination, seedlings of the weeds were transplanted into the pots. The study was terminated at anthesis stage of the weeds, then pre-and post-trial soil samples were analysed for selected soil fertility parameters: Soil pH, electrical conductivity (EC), organic carbon, ammonium-nitrogen, nitrate-nitrogen, and available phosphorus. The data was summarised using Statistix 10.0, then subjected to one-way analysis of variance (ANOVA).

Results and Discussion

There was no significant difference ($P < 0.05$) in terms of available P and $\text{NH}_4^+\text{-N}$ among the treatments after remediation with different weeds species. Findings showed that remediation with C2 and C3 resulted in acidic soil conditions (< 6.5). A decrease in EC was also observed after remediation for all treatments except (C3). Organic carbon slightly decreased in C3 and P, while available phosphorus decreased in A and B. $\text{NH}_4^+\text{-N}$ and $\text{NO}_3\text{-N}$ were highest in C0 (0.40 mg/kg) and C3 (0.23 mg/kg) and lowest in P (0.34 mg/kg) and C1 (0.09 mg/kg), respectively.

Conclusion

Soil pH and EC increased after eight weeks of irrigating the soil with treated wastewater. However, the results showed that remediation with the selected weeds decreased pH and EC, which could result in acidity. Organic carbon was not altered after remediation, but ammonium and nitrate nitrogen showed increased concentrations with remediation.

References**Keywords:**

agricultural weeds, phytoremediation, soil fertility, treated wastewater

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Introduction:

Mining has a negative impact on the environment, either directly, indirectly or cumulative. Consequently, mine-site rehabilitation is a legal requirement. Monitoring of mine-site rehabilitation, of which the monitoring of soil health is key, helps to ensure sustainability. In order to achieve its sustainable development objectives, the mining sector constantly seek to improve standards of rehabilitation. Hence, suitable strategies for monitoring mine-site rehabilitation are needed. An enzyme-based soil alteration index (AI3), which quantifies the balance between β -glucosidase, acid-phosphatase and urease activities, potentially enables differences in soil fertility between various stages of rehabilitation, to be quantified in relative terms. The research reported here is aimed at assessing the suitability of the AI3 as monitoring tool for mine rehabilitation assessment.

Materials and Methods

Soil samples were collected twice, in April 2019 and June 2020, from PPC De Hoek mine in Piketberg, Western Cape, South Africa (32° 56' 30.18" S, 18° 45' 28.98" E). The treatments were: Control (adjacent farm soil), Un-rehabilitated mined soil, 1-year rehabilitated mined soil, 10-year rehabilitated mined soil. Composite soil samples, comprising of ten sub samples each, were obtained from top- (0-15cm) and subsoil (15-30cm) layers. β -glucosidase, phosphatase and urease activities were used to calculate AI3 scores, using the formula and coefficients developed by Puglisi et al. (2006).

Results and Discussion

Based on AI3 scores and individual enzyme activity analyses, un-rehabilitated mined soil exhibited poorest soil health status relative to 1-year rehabilitated, 10-year rehabilitated and adjacent farm soil plots. Moreover, 10-year rehabilitated mined soil exhibited better soil health than 1-year rehabilitated soil and consistently exhibited soil health status similar to adjacent farm soil, suggesting a return of the land to some degree of its former state, i.e. reverting to a sustainable usable condition. Furthermore, individual enzyme activity and AI3 indices decreased with increasing soil depth, reflecting gradients in mineralizable substrates, which is in agreement with literature, and also correlated with soil nutrient status, i.e. with pH, P, K, S, EC, Na and Mg.

Conclusion

AI3 was able to quantify soil health status at various stages of mine rehabilitation. Thus, the approach used in this research potentially lends itself to wide application as a suitable monitoring tool for mine soil rehabilitation assessment.

References

Puglisi E, Del Re AAM, Rao MA, Gianfreda L. 2006. Development and validation of numerical indices integrating enzyme activities of soils. *Soil Biology and Biochemistry* 38: 1673–1681.

Keywords:

AI3 index, mine rehabilitation, soil enzymes, soil health

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Introduction:

The use of microorganisms for remediation purposes has recently become a possible solution for heavy metal pollution in agricultural soils, including pollution due to irrigation with treated wastewater. Therefore, the objective of this study was to investigate the bioremediation abilities of gram-positive and gram-negative bacteria on non-essential heavy metals in treated wastewater irrigated fields.

Materials and Methods

The study was a 2 (fields) × 8 (microorganism inoculants) factorial arranged in completely randomised design. Two fields, namely, cultivated field (CF) and fallowed field (FF), each being 4 ha, were identified and divided into 40 equal grids, equivalent to 40 m × 40 m, for sample collection. Soil samples were collected at 0-20 cm depth in each grid and were analysed for five non-essential heavy metals namely arsenic (As), aluminium (Al), cadmium (Cd), chromium (Cr) and lead (Pb). The isolated bacteria were identified as *Providencia rettgeri*, *Enterobacter cloacae*, *Bacillus cereus* and *Arthrobacter aureus*, and their combinations. The isolated bacteria were cultured and inoculated in heavy metal-contaminated soils and incubated for 12 weeks at 37°C. Data were subjected to factorial analysis of variance (ANOVA).

Results and Discussion

Results obtained showed that the field × inoculants effects were significant on Cd, Cr and Pb but were not significant on Al and As. Factor A (field) was not significant for all the selected non-essential heavy metals. Factor B (inoculants) was highly significant on Al, As, Cd, Cr and Pb. Results further indicated that gram positive bacteria reduced more concentrations of non-essential heavy metals separately and combined, especially in fallowed field. Cadmium and Pb were highly reduced by the combination of gram-positive bacteria by 95% and 83% respectively. Among the selected non-essential heavy metals Cr was the one which was highly bioremediated with a 100% removal by *P.rettgeri* in CF and by 98% by the combination of gram-positive bacteria. No reduction was observed for Cd by *A. aureus* in FF.

Conclusion

This study proved that bioremediation coupled with fallowing could be considered as a solution in ameliorating heavy metal toxicity while naturally improving the quality of the soil.

Keywords:

Treated wastewater, soil pollution, bioremediation, fallowing

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Introduction:

Soybean (*Glycine max*) is an important economic legume crop that serves as a source of protein and oil in Africa. Aside from nutritional attributes, soybean improves soil fertility through symbiotic relationship with rhizobia. However, soybean is sensitive to drought at various growth stages, which directly affect grain yield. The aim of this study was to assess N₂ fixation and water-use efficiency of 15 soybeans genotypes grown under rain-fed condition.

Materials and Methods

The genotypes were planted in a randomized complete block design at Bamahu in the Upper West region of Ghana. At the early pod filling stage, the shoots of five soybean plant were decapitated, weighed fresh and oven dried at 60 °C, and weighed. The samples were finely ground (0.085mm) and stored prior to ¹⁵N ¹³C isotopic analyses using mass spectrometry. The ¹⁵N and ¹³C isotopic values were therefore used to estimate N₂ fixation and water use efficiency, respectively.

Results and Discussion

The data revealed significant variation in symbiotic N contribution and water efficiency among the 15 genotypes. The shoot $\delta^{15}\text{N}$ values of the test genotypes ranged from -0.20‰ to +1.5‰. The percent N derived from symbiosis ranged from 23% and 73% while the amounts of N fixed ranged from 57 to 175kg N ha⁻¹. Genotype TGX 2014-23FM and Maksoy1N demonstrated superior shoot dry matter accumulation, N and C content, symbiotic N contribution and shoot $\delta^{13}\text{C}$ values. The differences in $\delta^{13}\text{C}$ ranged from -28.59‰ to -30.11‰, with genotype SC status, TGX 2014-23FM and Favour exhibiting higher shoot $\delta^{13}\text{C}$ values of -28.59‰, -28.96‰ and -28.59‰, respectively; an indication of their increased water-use efficiency relative to the other genotypes. Although genotype SC status had high shoot dry matter, N content and shoot $\delta^{13}\text{C}$, it derived lower percentage of its N requirement (23.3%) from symbiosis and fixed the lowest amount of N (52.72 kg ha⁻¹). This shows that SC status relied heavily on soil N to meet its N nutrition than symbiosis.

Conclusion

In conclusion, the 15 soybean showed a genotypic variations in the symbiotic performance and water relation.

The study highlighted that soybean is higher N₂ fixer, with N derived from symbiosis ranging from 23% and 73%. Of this, we identified TGX 2014-23FM and Maksoy1N as good genotypes for use in poor resource farmers in Ghana as they derive more than 65% of N from fixation, as well as produced about 155-175 kg ha⁻¹ and showed improved water use efficiency among other genotypes.

Keywords:

Soybean, N₂ fixation, water-use efficiency

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Introduction:

Carbon dioxide (CO₂) is one of the main greenhouse gases and thus, it is of paramount importance to monitor it and curtail its emission into the atmosphere. Although the highest CO₂ emissions are reported by industrial activities, agricultural fields contributes about 10–14% towards total emissions (Asner et al., 2010). The influence of land use type on CO₂ emission is not well elucidated, thus this study is aimed at attaining a better understanding of the effect of land use type on the emission of CO₂ from the soil (Anokye et al., 2021).

Materials and Methods

The study was conducted at the Letaba catchment under five land use types namely Eucalyptus grandis plantation, banana plantation, communal maize field, forest and natural bushes. The emission of CO₂ and the moisture content data was collected at a 2-week interval from April to mid October 2021.

Results and Discussion

The rate of CO₂ emission was highest during the autumn season with an average of 3.56 mg/m²/min making it 55.62% greater than the rate observed in winter and 48.88% higher than observed in spring. The soil moisture content was highest during autumn with an average moisture content of 7.86% making it 5.22% greater than that during winter and 39.69% greater than that during spring. Soil CO₂ emission rate and moisture content were highest under the banana plantation during all the seasons and was lowest under the open bushland. The regression between CO₂ emission and the soil moisture content was very low and weak under all the land use types with the weakest regression of $r^2=0.003$ under the banana plantation and the highest of $r^2=0.246$ under the Eucalyptus grandis plantation.

Conclusion

The current results show that CO₂ emission rates vary significantly with land use as well as with season. The results also suggest that the emission of CO₂ in the studied land uses is not solely dependent on the moisture content of the soil, but other soil factors could be the drive of CO₂ being released from the soil.

References

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Keywords:

Carbon dioxide, Emission, Land use,

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Introduction:

Data on the spatial variability of soil observed within a field is essential to meet the basic objectives of site-specific management of agricultural input, which plays a role in increasing the profitability of crop production, protect the environment and improve the quality of the product. In South Africa, the amount of soil information from various corporations is large, but not available outside of the holders of the data. The shortage of soil data hinders increased adoption of Precision Agriculture PA and development strategies for sustainable soil management. Therefore, the development of a soil database containing standardized soil information will contribute to the estimations of present and future soil productivity potential in South Africa. The performance of quality control measures will result in the development of an accurate and comprehensible soil database that can be expanded overtime.

Materials and Methods

The WoSIS and ARC-ISCW point databases were chosen for SWOT analysis to evaluate the Strengths, Weaknesses, Opportunities and Threats that can emerge from the development of a database, and from this the NWU soil database structure was proposed. Point soil data was collected from various sources in South Africa and recorded in the NWU soil database with the accompanying soil morphological and analytical properties. Quality control measures were performed using statistical analysis including outlier detection and correlation tests to evaluate the quality of the recorded data.

Results and Discussion

As a result of the evaluation of the SWOT analysis, the NWU soil database was developed in a way that it can be used to record soil data collected from various sources, recorded in different formats and created for different purposes. The final product of the NWU soil database was composed from a total of 25 sources resulting in a total of 539 soil profiles and 1518 soil horizons. The soil data was quality controlled and used to characterise the soil based on the various soil properties recorded in the soil database.

Conclusion

Soil data from various sources can be collected, quality-controlled and recorded in a common soil database, that is complete, comprehensible and user-friendly. This will lead to the gradational reduction of the paucity of soil data availability in South Africa.

References

Keywords:

Database structural design, Sustainable Agriculture, Data availability, WoSIS database, ARC-ISCW database,

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Introduction:

Obtaining good quality soil parameter maps for crop and hydrological modelling is a global challenge. Existing databases are not always easily accessible or reliable, and it is time-consuming to gather the necessary parameters in the correct format. While there are several databases available for South Africa, our highly heterogenous soil types leads to uncertainty in the application of these parameters. To address water scarcity, climate change, and other challenges with the help of predictive modelling, it is imperative reliable soil parameter databases and maps are available.

Materials and Methods

The study areas selected were experimental farms in Hatfield, Outeniqua, and Pongola, and were chosen because the historical soil data was carefully measured and the sites occur in different regions of South Africa. Measured clay and silt percentage, bulk density, and organic carbon content values were compared to estimated values obtained from World Inventory of Soil Emission Potentials (WISE) and Africa Soil Information Service (AfSIS). Profile parameters were compared at 5 cm increments.

Results and Discussion

Clay % estimations showed that AfSIS performed better closer to the surface while WISE performed better deeper in the profile. Alarming discrepancies were found in both datasets, particularly for Outeniqua, where AfSIS overestimated values by 280-603% and WISE overestimated values by 396-745%. Both datasets underestimated clay % in Pongola by up to 35%. For Hatfield, AfSIS underestimated by up to 33% and WISE overestimated by up to 37%. Silt % estimations for both datasets showed high overestimations by at least 80% across all three sites. Bulk density (kg/m³) estimations were the least problematic but still had differences of approximately 15% across all three sites. Organic carbon % values for Hatfield illustrated overestimations for the top of the profile and were more accurate deeper in the profile for both datasets. In Outeniqua, WISE overestimated by between 24-106% and AfSIS underestimated by between 33-60%. Both datasets overestimated organic carbon % in Pongola, with WISE differing between 23-91% and AfSIS differing between 15-220%.

Conclusion

As seen from the results, large discrepancies exist in both WISE and AfSIS estimated parameters and should therefore be used with absolute caution. There is no clear "winner" between the two databases, however, AfSIS uses the same parameter value throughout a soil profile, whereas WISE has unique values per layer. In the same breath, WISE generally over or underestimates parameters more severely than AfSIS does. This study places emphasis on the importance of creating a local, accurate database.

Keywords:

Big data, DSSAT, soil maps, SWAT

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Introduction:

Demonstration plots, when well planned, designed and implemented, provide an opportunity for beneficiaries to observe the application of new technologies coupled with the benefits derived from them. Not only are demonstration plots an effective educational tool that provides an opportunity to acquire new skills and knowledge on the technologies, but they are also a research and development platform for researchers, extension staff and farmers to interact. An agricultural demo plot is a site set aside to: 1) demonstrate innovative agricultural practices under local conditions, allowing the farmer and community to evaluate the relative merits of the practice ("seeing is believing"); and 2) foster learning and knowledge transfer concerning the agricultural practices through the site itself, the farmers who are working on the demo plot, and the activities associated with it ("learning by doing").

Materials and Methods

Field demonstration trials were conducted over five growing seasons (2015/2016 - 2019/2020) at homesteads and on croplands at Krwakrwa (32°44'43" S; 26°54'34" E) in the Eastern Cape to showcase in-field rainwater harvesting (IRWH) as a sustainable technology for crop production. Households suitable for the demonstration of the IRWH technology were identified using strict selection criteria. At the demo plots, community members received hands-on training on the construction and maintenance of the IRWH system as well as the planting of crops. The IRWH technology was compared with the conventional farming practices.

Results and Discussion

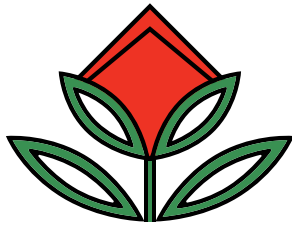
Through interactive learning at the demonstration plots, community members were equipped with the necessary knowledge and skill to successfully implement and apply the IRWH technology for the production of cash crops and a variety of vegetables at their homestead gardens. Visual differences in the production on the IRWH and conventionally tilled plots assisted to convince community members of the superiority of the IRWH system and resulted in widespread adoption of the new technology.

Conclusion

Demonstration plots can be used as an effective technology transfer tool to teach various agricultural techniques and to showcase new or improved crops in a rural community. They also serve as a platform to test new methods alongside traditional ones under a controlled environment. The group-based adult learning approach followed teaches small-scale farmers how to experiment and solve problems independently. They can meet regularly with the researchers and technical assistants at the demonstration plots to observe, discuss, ask questions and learn together.

Keywords:

demonstration plots, education method, rural communities



COMBINED CONGRESS

Annual congress of
SSSSA, SASHS & SASCP

Abstracts

Oral presentations:
Crop Science
(SASCP)

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Introduction:

Globally, water and nitrogen have been recognized as the main resources that significantly affect crop productivity. Water Efficient Maize for Africa (WEMA) is a drought-tolerant maize variety recently introduced and grown in many areas of Africa as part of smart response to the challenge of drought occasioned by climate change. This study evaluated the response of WEMA variety to different soil moisture levels and nitrogen fertilizer rates on Ferric Luvisol and Rhodic Ferralsol soils. We hypothesize that the growth parameters and yield of this drought tolerant maize variety will perform differently under varying N regimes and soil conditions.

Materials and Methods

A greenhouse experiment was carried out at North-West University (NWU) Research Farm between February- June 2018 using WEMA variety 3127. The experiment was laid out in a 5 x 2 x 2 factorial experiment fitted into a completely randomized design with three replications. Treatments comprised of five N fertilizer rates (0, 60, 120, 180 and 240 kg N/ha), two soil moisture levels [45 and 100% field capacity] and two soil types (Ferric Luvisol and Rhodic Ferralsol). Plant height, chlorophyll content and total dry matter weight as growth attributes, grain yield, total biological yield and water-use efficiency parameters were determined.

Results and Discussion

The tallest plants (283.33 cm) were recorded in Ferric luvisol supplied with 240 kg N/ha at 100% field capacity. The chlorophyll content of the WEMA variety was highest in the Rhodic Ferralsol supplied with 120 kg N/ha and watered to a 100% field capacity. The Rhodic Ferralsol supplied with 180 kg N/ha under a 100 % soil moisture level had the highest total dry matter weight (71 g). Highest grain yield (136.8 g /pot) and water-use efficiency (1.94%) were obtained in Rhodic Ferralsol treated with 180 kg N/ha at 100% and 45% field capacity respectively.

Conclusion

The results showed that the growth and water use efficiency of WE3127 maize variety were better on Rhodic Ferralsol than in Ferric Luvisol. This newly released maize variety can be better cultivated with greater grain yield under limited soil moisture condition in a Rhodic Ferralsol than Ferric Luvisol with application of 180 kg N/ha.

Keywords:

Grain yield, water-use efficiency, WEMA variety

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2	Prof Sue Walker	Agricultural Research Council - Natural Resources and Engineering, Private Bag X79, Pretoria 0001, South Africa Department of Soil, Crop and Climate Sciences, University of the Free State, Bloemfontein, South Africa

Introduction:

The impact of climate change on food production in South Africa is likely to increase due to low rainfall and frequent droughts, resulting in food insecurity in the future. The use of well-calibrated and validated crop models together with climate change data can be useful for assessing climate change impacts and developing adaptation strategies. In this study the DSSAT crop model was used to predict yield using observed and projected climate data.

Materials and Methods

Climate, soil and crop management data information were collected for wheat growing study sites in Bethlehem, South Africa. The DSSAT wheat crop model (CROPSIM-CERES) was calibrated and validated using three wheat cultivar coefficients obtained from the cultivar adaptation experiment of ARC-Small Grain. The model was run with historical climate data for the eastern Free State (Bethlehem) from 1999-2018 as the baseline period. To determine the effects of climate change, the crop model simulation for wheat was run with future projections from four Global Climate Models (GCM): BCC-CSM1_1, GFDL-ESM2G, ENSEMBLE AND MIROC from 2020-2077.

Results and Discussion

The average wheat grain yield for the historic climate data as at 2020 was 1534 kg/ha. The highest average yield of 1215.9 kg/ha from 2020-2069 was produced during RCP 2.6 and GCM ENSEMBLE while the lowest yield of 29.8 kg/ha was produced during RCP 8.5 and GCM GFDL-ESM2G. The GCM GFDL-ESM2G model produced very low yields ranging from 29.8 kg/ha during RCP 8.5 to 47.74 kg/ha during RCP 6.0, while the average yield for GCM ENSEMBLE ranged from 1064.38 kg/ha during RCP 8.5 to 1215.9 kg/ha during RCP 2.6. The yield range for GCM BCC-CSM1_1 was 770.2 kg/ha during RCP 2.6 to 921.68 kg/ha during RCP 4.5, while for GCM MIROC it was 547.84 kg/ha during RCP 8.5 to 700.22 kg/ha during RCP 2.6. The baseline yield was slightly higher than the highest from the future data. The results from this study showed a declining trend in yield for all future climate projections from RCP2.6 to RCP8.5, indicating that the possible impacts of higher temperatures and reduced rainfall in projected future climate will slightly decrease wheat production in the eastern Free State.

Conclusion

Adaptation measures to mitigate the potential impact of climate change could include possible changes in planting dates and irrigation selection. Using a crop model to simulate the response of crops to variation in weather conditions can be useful to generate advisories for farmers based on the potential effects of climate change on yield.

Keywords:

Crop model, DSSAT, South Africa, Wheat,

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Introduction:

Potatoes (*Solanum tuberosum* L.) are highly susceptible to late blight (*Phytophthora infestans* (Mont.) de Bary), which can cause large yield reductions. As rural householders cannot always afford to purchase fungicides to control this disease, a study was conducted on an irrigated Hutton soil at the Cedara Research Station, KwaZulu-Natal, to evaluate the tolerance of twelve potato cultivars to late blight in the 2018/19, 2019/20 and 2020/21 growing-seasons.

Materials and Methods

A split-plot design with three replicates was used. The main plot, cultivar, was split for a) weekly fungicide applications from ridging and b) no fungicides applied. Six fungicides (a.i. mancozeb/metalaxyl-M, difenoconazole, cymoxanil/mancozeb, mancozeb, cymoxanil/famoxadone and chlorothalonil) were applied weekly in a rotation. The trials were planted on 19/09/2018, 18/09/2019 and 16/09/2020 at a seeding rate of 37 037 tubers/ha. Weekly disease severity ratings were done from ridging and the days to 90% senescence were determined for the 2019/20 and 2020/21 growing-seasons only. The tubers were graded and weighed according to size.

Results and Discussion

Total rainfall and irrigation received in the respective growing-seasons was 703.3 mm, 723.4 mm and 698.6 mm. High quantities of rainfall plus irrigation in November 2020 together with above-average temperatures resulted in quicker development and spread of late blight compared to the 2019/20 growing-season. As a result, the mean number of days to 90% senescence was 114.5 in the 2020/21 growing-season compared to 123.8 days in the 2019/20 growing-season. A significant interaction was measured for the number of days to 90% senescence between the cultivars and fungicide treatments, however, no significant differences were measured for El Mundo, Electra, Panamera, Sababa and Valor. Overall, fungicides extended the time to 90% senescence by 13.78 days. The percentages of large and large/medium tuber mass were significantly higher with fungicide applications. The reduction in mean yield resulting from not applying fungicides was 10.99 t/ha, overall. Electra produced significantly higher mean yields with and without fungicides (69.75 t/ha and 63.98 t/ha, respectively) compared to the other cultivars. When comparing the effect of the fungicide treatments on individual cultivars, no significant differences in yield were measured for El Mundo only (mean = 52.16 t/ha). However, without fungicides, Sababa and Valor produced insignificantly different mean yields to El Mundo.

Conclusion

Apart from El Mundo, fungicide applications are essential to optimize potato yield. Rural householders who cannot afford to buy fungicides should plant Electra, El Mundo, Sababa or Valor.

Keywords:

disease severity, late blight, senescence, tuber mass, yield

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Introduction:

Wheat production is hindered by drought stress. Drought breeding is complex and polygenic in nature, therefore, indirect selection of agronomic traits and grain yield (GY) is used to improve drought tolerance. Silicon (Si) application is used to improve nutrient uptake and mitigate drought stress. However, its effects on agronomic trait associations and indirect selection for drought tolerance breeding have not been widely investigated. The objectives of this study were to examine the impact of Si fertilizer application on agronomic performance and trait association in response to drought, in developing an indirect selection strategy for improving drought tolerance in wheat.

Materials and Methods

Twenty wheat genotypes were evaluated under factorial experiment, under three environments, involving two water regimes and two Si fertilizer formulations, a granular potassium silicate (KSiO₄), a liquid KSiO₄, and, an untreated control. Agronomic traits: Plant height (PH), productive tiller number (TN), productive spike number (PS), spike length (SL), spikelets per spike (SPS), kernels per spike (KPS), hundred seed weight (HSW), aboveground biomass (AGB), harvest index (HI), and grain yield (GY) were measured, and the data were subjected to correlation, and path coefficient analyses to evaluate trait associations for indirect selection of GY and drought tolerance.

Results and Discussion

Under both stressed and non-stressed conditions, traits with the strongest correlations with GY were TN, PS, SL, KPS, AGB across all treatments. Si application improved the relationship between agronomic traits under both stressed and non-stressed conditions. Under drought stress, the strongest correlation for GY was exhibited by TN ($r = 0.898$, $p < 0.001$) after liquid Si, AGB ($r = 0.887$, $p < 0.001$) after granular Si and ($r = 0.875$, $p < 0.001$) for control. Liquid Si application under non-stress, strengthened TN, and PS correlation under drought ($r = 0.996$, $p < 0.001$) and non-stressed ($r = 0.994$, $p < 0.001$) compared to the granular Si and control. The highest direct effects on GY under stress were exhibited by TN (1.09) after liquid Si application compared to 0.22 after granular Si application and 0.74 for the control treatment. Under non-stress, TN had the highest direct effects on GY with Si liquid formulation compared to AGB with granular Si application and KPS for the control.

Conclusion

The stronger correlations and direct effects exhibited under Si liquid formulation show that the application of Si enhances agronomic performance, by improving nutrient uptake and drought tolerance but its effects are influenced by formulation. Trait TN should be targeted for improving GY, especially under drought stress for Si-use efficiency selection.

References

Keywords:

Silicon fertilizers, Silicon-use efficiency, wheat, breeding, Pearson's correlation, Regression analysis, Path coefficient analysis

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Introduction:

Abiotic stressors that limit maize (*Zea mays* L.) yield include heat stress and drought. These stressors can act alone or in concert to reduce maize yield. It is necessary in a breeding programme to identify the appropriate traits that influence yield in a given stress environment. The objective of this study was to identify the morphological traits that contribute to maize grain weight (GWt) under abiotic stress conditions.

Materials and Methods

During the 2018/2019 and 2019/2020 summer planting seasons, a completely randomized design experiment with four replications was conducted at the North-West University Experimental Farm (25°47'24.1"S 25°37'17.3"E), Mafikeng campus, North West Province, South Africa. Three drought-tolerant maize varieties (WE3128, WE5323, and ZM1523) were grown under no-stress (NHS), heat-stress (HS), and combined heat and water stress (HWS) conditions. The cobs were harvested at physiological maturity and were shade-dried until 12% moisture content. Data from 19 morphological traits were analysed using Pearson's correlation coefficient, principal component analysis, and path coefficient analysis.

Results and Discussion

Under NHS, HS, and HWS, the correlation results revealed that eight traits (number of leaves, dry biomass yield, harvest index, cob length, cob width, shelling percentage, grain number, and cob weight) consistently produced a significant and positive relationship with GWt. The principal component analysis explained 59.37% of the variation under NHS, 55.12% for HS, and 57.14% under HWS. The path coefficient analysis revealed that in the NHS, HS, and HWS conditions, five traits (plant height, harvest index, cob length, cob weight, and grain number) consistently had a positive direct effect on the GWt. The contributions of the other traits to the GWt varied according to stress levels. Given the magnitude of the positive direct effects, increasing dry biomass yield, harvest index, and grain number in the NHS; grain number, harvest index, and cob width in the HS; and harvest index, days to silk appearance, leaf chlorophyll content, and grain number in the HWS will increase GWt.

Conclusion

Under various abiotic stress conditions, maize phenotypic expression varied. Therefore, the identified traits that contributed positively to GWt under various stress conditions should be taken into account when developing a maize improvement programme in a related stress-prone environment.

Keywords:

Abiotic stress, correlation coefficient, path coefficient analysis, principal component analysis, yield improvement, *Zea mays* L.

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Introduction:

Glyphosate is a broad-spectrum chelator to macro- and micronutrients and can potentially impact nutrient availability of some nutrients. An undersupply of nutrients could impact photosynthesis and plant growth. The aim of the study was to investigate whether glyphosate combined with foliar nutrient products in tank mixtures would negatively impact nutrient uptake by the plant.

Materials and Methods

Glasshouse trials conducted at Agricultural Research Council-Grain Crops, Potchefstroom, during 2017/18 and 2018/19 (18°C/30°C (+/- 5°C) included two Roundup Ready® maize cultivars (DKC73-76R and BG5685RR) planted separately in 80ℓ pots, with each pot representing a replicate (1 plant per pot). A split-plot design (cultivars - main plots; treatments - sub-plot) was used. Ten treatments, (four replicates), were applied at V6 stage and consisted of four nutrient products [NutriVo (2 ℓ ha⁻¹, NutriCo), MolboroX (2 ℓ ha⁻¹, NutriCo), X-Press Functional (2 ℓ ha⁻¹, MBFi) and Yield Stimulant (560 ml ha⁻¹)] applied separately and in combination with glyphosate (Roundup PowerMax® (2 ℓ ha⁻¹) + All-round (2%)(ammonium sulphate)). A glyphosate only application and untreated control was included. At flowering, the leaf directly opposite the ear, was sampled, dried and sent to ARC-Institute for Soil, Climate and Water for leaf analyses. Ca, K, Mg, Na, P, B, Cu, Fe, Mn and Zn concentrations were determined. Plant and threshed kernel weight per plant were obtained as well as 50-kernel weight, rows per ear (RpE) and kernels per row (KpR) at maturity. All parameters were expressed as a percentage of the control. Analyses of variance were conducted over the two seasons.

Results and Discussion

RpE, 50-kernel weight, K, Ca, Mg, Zn, P as well as Fe were not negatively affected by the addition of glyphosate to any of the four products included. For the remaining parameters evaluated, effects observed were season and/or cultivar dependent in most cases.

Conclusion

Glasshouse trials were not able to demonstrate the significant, consistent yield loss or reduction of macro- and micronutrients in leaf samples due to the use of glyphosate with foliar nutrient products in tank mixtures.

Keywords:

Glyphosate, chelation, micro- and macronutrients, leaves

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Introduction:

International research suggests greater occurrence of stalk rot incidence under severe Northern corn leaf blight (NCLB) infection (Dodd, 1980). Since the 1980's, the association between a leaf disease such as NCLB and root, crown and stalk rots received little attention. The aim of this study was to establish whether stress induced due to NCLB infection in three maize hybrids with varying degrees of NCLB resistance, would impact on their eventual root, crown and stalk rot observed.

Materials and Methods

Two field trials were conducted during 2016/17 and 2017/18 respectively (November and December planting dates) at the Agricultural Research Council-Grain Crops, Potchefstroom. Three maize cultivars with varying NCLB resistance levels were included (IMP50-10B - susceptible, BG3292 – moderately susceptible and DKC 61-94BR - resistant). Eight treatments were applied i.e. TMT1 - maximum control (3 fungicide applications); TMT2 - standard control (2 fungicide applications); TMT3 - natural control (not inoculated or sprayed). Remaining treatments were inoculated with a mixture of five NCLB races (Race 3, 3N, 23, 23N and 13N): TMT4 (5 weeks after planting - WAP); TMT5 (5+6 WAP); TMT6 (5+6+7 WAP); TMT7 (6+7 WAP); TMT8 (7 WAP). Six randomly selected plants were sampled at V12, flower, milk, soft dough and dent stage respectively and screened for NCLB development, root, crown and stalk rot. Regression analyses were conducted between NCLB and root and crown rot severity only, as no stalk rot occurred.

Results and Discussion

Significant regression analyses obtained, were attributed to natural root and crown rot increases that occurred over time, independent of NCLB development. Significant fitted models were limited to NCLB severities achieved at the later maize growth stages (soft dough and dent stage).

Conclusion

NCLB severity is most probably only a contributing factor to a host-pathogen-environment interaction associated with root, crown and stalk rot.

References

Dodd, J.L. (1980) The role of plant stresses in developing of corn stalk rots. Plant Disease, 64, 533-537.

Keywords:

epidemic onset, resistant, stress induced, susceptible

NITROGEN FERTILISATION OF CANOLA (BRASSICA NAPUS L.) PRODUCED IN CONSERVATION AGRICULTURE SYSTEMS IN THE WESTERN CAPE, SOUTH AFRICA

Oral

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Introduction:

Conservation agriculture (CA) increases organic carbon and the nitrogen (N) mineralisation potential of soil. We postulate that the current N guidelines lead to over fertilisation as current N fertilisation guidelines are adopted from conventional tillage practices. The aim of the study was to investigate the effect of different N fertiliser application rates and foliar N on biomass production, seed and oil yield of canola in an effort to refine N management strategies under CA in the canola production sub-regions of the Western Cape.

Materials and Methods

Field trials were executed at Darling, Porterville, Moorreesburg, Riviersonderend and Riversdale from 2016 to 2019. Eight N rates ranging from 0 to 190 kg N ha⁻¹ in the form of limestone ammonium nitrate (LAN) applied at the 4-5 leaf stage were evaluated. Each N rate treatment was followed by a foliar application of 0 kg N ha⁻¹ or 20 kg N ha⁻¹ in the form of a urea ammonium nitrate (UAN) solution at the stem elongation stage. A randomised block design with four replications was followed. Biomass production (kg ha⁻¹) was determined at the 65% seed colouring stage and a small plot combine harvester was used to harvest plots to determine seed yield (kg ha⁻¹), oil content (%) and oil yield (kg ha⁻¹).

Results and Discussion

Biomass production response to increasing N rate was poor and varied with seasonal rainfall. Seed and oil yield response to N rate was determined by residual soil N supply and soil water availability following N application. With exception of Moorreesburg, maximum seed yield response to N rate were found at lower N rates than recommended by Fertasa for canola at the specific sites. Foliar N application had no effect ($p < 0.05$) on biomass production (all sites), seed yield (at Darling, Porterville, and Riversdale) and oil yield (at Darling), while at Moorreesburg (2016 and 2017) and Riviersonderend (2016, 2017 and 2019) foliar N increased seed yield.

Conclusion

Canola response to N rates varied across sites and years, but were generally lower than the recommended fertiliser guideline. The general lack of response in biomass production, seed and oil yield to N rates reflects the possible build-up of high plant available N levels under CA conditions.

References

Keywords:

Conservation agriculture, fertiliser, nitrogen, canola, nitrogen rates, foliar nitrogen

NITROGEN SOURCE EFFECTS ON CANOLA (BRASSICA NAPUS L.) GROWN UNDER CONSERVATION AGRICULTURE IN THE WESTERN CAPE, SOUTH AFRICA

Oral

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Introduction:

Limited research exists on the effects of nitrogen (N) source on canola growth and yield parameters when grown under conservation agriculture (CA). By choosing the correct source, rate, timing, and placement of N fertiliser, canola growth and yield can be improved. The aim of the study was to investigate the impact of applying different N sources on canola biomass production, seed yield, and oil content grown under CA in the Western Cape Province.

Materials and Methods

Canola was planted at five sites (Darling, Porterville, Moorreesburg, Riviersonderend and Riversdale) differing in soil properties and climatic conditions in the grain producing areas of the Western Cape. Experiments were laid out in a randomised block design with four blocks. Five N source treatments (urea, urea + urease inhibitor, limestone ammonium nitrate, ammonium nitrate + sulphur and ammonium sulphate) were investigated over four years (2016 – 2019). Each plot received a total of 25 kg N ha⁻¹ at planting. Nitrogen source topdress applications took place at the 4- to 5-leaf stage and total N applied was based on site-specific guidelines for canola. Aboveground biomass was determined at the 65% seed colouring stage. A small plot combine harvester was used to harvest plots to determine yield (kg ha⁻¹) and oil content (%). Data were subjected to a weighted combined analysis of variance (ANOVA) and Fisher's least significant difference was calculated at the 5% level to compare treatment means.

Results and Discussion

Nitrogen fertiliser source had no effect ($p > 0.05$) on biomass production or oil content at any site. Higher ($p < 0.05$) yields were obtained for the urea + urease inhibitor fertilizer treatment in both sandy and shale-derived soils where N application was followed by regular rainfall events that allowed for the gradual utilization of N by plants. Urea promoted higher yields where N application was shortly followed by sufficient rainfall to initiate plant N uptake. In heavier, shale-derived soils, N sources that contain highly mobile plant-available nitrate and ammonium delivered higher ($p < 0.05$) yields.

Conclusion

Climatic conditions were considered the main determinants of biomass production and oil content as N fertiliser source did not influence the parameters. Yield differences were site-specific, suggesting that each site should be managed according to its inherent soil and climate conditions.

Keywords:

Conservation agriculture, fertiliser, nitrogen, canola, sources, yield

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Introduction:

Soybean (*Glycine max* L. Merrill) is an annual herbaceous leguminous grain crop which is cultivated mainly for its oil and protein purposes. The objective of the study was to determine the effects of plant density and zinc added to phosphorus fertilizer sources on soybean yield performance under different environmental conditions.

Materials and Methods

A field trial was executed at Mafikeng and Taung sites during the 2018/19 and 2019/20 summer planting seasons. The experimental design was a 2 x 2 x 5 factorial fitted into a randomized complete block design (RCBD) with four replications. The experiment consisted of two plant densities, a lower plant density of 66 666 plants/ha and a higher plant density of 111 111 plants/ha. The five different types of fertilizer treatments were single superphosphate, monoammonium phosphate, zinc sulphate added to single superphosphate, zinc sulphate added to monoammonium phosphate and control. The parameters measured in this trial were number of pods/plant, pod mass, grain yield, 100 seed mass and field biomass.

Results and Discussion

The results showed that plant density has a significant effect ($P < 0.05$) on soybean number of pods per plant and the field biomass yield. Soybean planted under lower plant density conditions produced a significantly higher number of pods per plant during both planting seasons, whereas higher plant density conditions resulted in a higher soybean field biomass yield during the 2018/19 planting season. The application of phosphorus fertilizer sources/zinc had a significant effect ($P < 0.05$) on pod mass and grain yield. It was observed that soybean treated with SSP had a greater pod mass and a higher grain yield.

Conclusion

A low plant density produced a greater number of pods per plant and a greater 100 seed mass. In terms of location, Taung produced higher number of pods, pod mass, 100 seed mass, grain yield and field biomass yield this might have been due to climatic and environmental conditions prevailing in Taung. Single superphosphate usage is recommended for higher soybean grain yields.

References

Keywords:

Biomass, grain yield, location, pod mass and seed mass

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Introduction:

Bread wheat is an important cereal crop worldwide, which provides >20% of the calorie intake. It is a source of minerals, carbohydrates, and proteins. However, the wheat grains are inherently deficient in micronutrients, particularly iron (Fe) and zinc (Zn). Due to consumption of diets poor in Fe and Zn, over 3 million people around the world, especially women and children in developing countries, are affected by micronutrient malnutrition. The study aimed to determine the genetic variation of grain Fe and Zn concentrations and their associations with yield components in wheat.

Materials and Methods

Doubled haploid (DH) lines derived from a cross between Tugela-DN and Elands cultivars were planted using an augmented design (Federer, 1961) in three locations (Arlington, Bethlehem, Harrismith) during 2017/18 and at Bethlehem during 2018/19 seasons. The parental cultivars were replicated four times and DH lines replicated once per sample. ICP-OES was used to measure the grain Fe and Zn concentrations. The ANOVA and correlations were evaluated using GenStat 18th ed. software.

Results and Discussion

All traits showed approximately normal distributions suggesting polygenic inheritance. Overall, a wide range of phenotypic variation was observed for all traits in DH lines. Grain Fe concentration ranged from 37.61 to 96.62 mg/kg, with a mean of 64.1 mg/kg. Grain Zn concentration ranged from 35.43 to 75.20 mg/kg, with a mean of 51.5 mg/kg. A total of 22 best-performing DH lines showing high GFeC and GZnC, together with high values for one or more grain yield components were selected. For example, genotypes TE1 and TE15 had the highest GFeC and GZnC, respectively. Grain iron and zinc concentrations were positively correlated in all environments, suggesting that these traits can be improved concurrently. The correlations between these minerals and yield components were inconsistent and ranged from significant to insignificant depending on the environment, indicating that this relationship was non-genetic.

Conclusion

There is sufficient variation of all traits among the evaluated genotypes, which can be exploited for use in wheat biofortification breeding program. The results demonstrate that biofortification of both grain iron and zinc concentrations can be included as part of the breeding objectives and will not necessarily have adverse relationships with grain yield components. This study provides useful benchmark information concerning the variation of grain iron and zinc concentrations and will advance the genetic improvements in Marker-assisted Selection breeding of South African bread wheat genotypes. The 22 best-performing DH lines are currently undergoing seed multiplication in the glasshouses at ARC-SG.

References

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Keywords:

GFeC, GZnC, Hexaploid wheat, Yield-related traits

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Introduction:

Canola is the most important rotation crop in the Western Cape rain fed production area. The seed yield of the different canola genotypes differ significantly. The yield of the Clearfield tolerant cultivars were on average 17.5% higher than the Triazine tolerant cultivars over the last three years. According to the GRDC (Australia) canola remove about 40kg N.ton-1 of seed. The hypothesis for this study was that a variety with lower seed yield potential will remove less N.ha-1, thus requiring less applied N fertilizer, with the ultimate goal of a net saving on input cost.

Materials and Methods

Three varieties were tested over two seasons (2019 and 2020) with eight nitrogen levels varying between 3 and 113kg.ha-1. The trials were planted with a fertilizer mixture, 1:4:2 (24), which resulted in a 3kg.ha-1 application at plant. The rest of the fertilizer application was applied as either a single or a split topdressing. A randomized complete block design with three replications were used.

Results and Discussion

In 2019 (Langgewens) the yield of 43Y92, the higher yield potential cultivar, increased up to a total nitrogen application of 43 kg.ha-1. The two lower yield potential cultivars showed a response up 53kg ha-1. In 2020 there was no yield response to different levels of N. During the 2019 growing season at Riversdale, the rainfall was below long-term average with above average temperatures during the seed fill stage, resulting in no response to N rate. During 2020 the seed yield increased with increased nitrogen application for all three yield potentials.

Conclusion

The response to nitrogen application varied between years and localities. In two of the trials there were no response to nitrogen application and little variation in the response between the varieties was noted in the trials with a response. The yield response in canola under rain-fed conditions, along with possible nutrient use efficiency needs more in-depth research.

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Keywords:

Canola, input costs, Nitrogen, Variety

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Introduction:

Crop rotation (CR) has long been a practical tool to improve crop diversity and one of the three main principles that define Conservation Agriculture (CA). It is also described as a cornerstone for livestock integration. More research is needed on individual CR's on their agricultural performance over long-term management, especially in the Swartland region of the Western Cape province. Therefore, this study aimed to examine 17 years of long-term data from a CR trial consisting of two cash crops, wheat (*Triticum aestivum*) and canola (*Brassica napus*), in South Africa's Western Cape province.

Materials and Methods

The trial was established in 1996 and consists of eight (A-H) CR's located on Langgewens Research farm in the Swartland district of Western Cape province. Crop rotations (A-D) are considered cash-crops systems, whereas system (E-H) is livestock integrated systems. Crop rotations were then scored on a key performance method with indicators important in the local CR systems. A random forest (RF) model was fitted to analyse the importance of score in relation to climatic variables and soil organic carbon (SOC) when predicting relative yield—using RStudio version 4.1.1 (R.2021). Relative yield data were then statistically assessed using Statistica version 14.0 with R integration middleware and analysed using a mixed-effect linear model with the system, sequence, and year as fixed factors and camp number as a random factor. The coefficient of variation (CV) was also calculated to determine yield stability over time.

Results and Discussion

The scoring system index showed the lowest score for CR A=Wheat-Wheat-Wheat-Wheat (monoculture) and the highest for CR H= Wheat-Saltbush-Medic/clover mix-Wheat-Saltbush-Medic/clover mix (most diverse CR system).

The RF outputs support this result showing that the scores strongly correlate with relative yield compared to climatic and SOC variables. Furthermore, the scoring system approach correlated with the pairwise comparison, confirming that the higher-scoring CRs differed significantly from the lowest-scoring CRs. Moreover, higher-scoring systems showed more stable yields over time compared to lower scoring CRs.

Conclusion

Crop diversity and livestock integration play an essential role in the long-term yield performance and sustainability of cropping systems within CA farming. Substituting at least one crop within a monoculture improves relative yield over the long term. Therefore, the scoring system can be used as a valuable tool to differentiate between the individual cropping systems predicting yields and guiding the applicability of CA in South Africa.

Keywords:

Conservation Agriculture, cash crops, pastures, scoring system, yield stability

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Introduction:

South Africa is known for being food secure on a state level. At the household level, however, rural families continue to face hunger, malnutrition, and poverty (Mavengahama et al. 2013; Oldewage-Theron et al. 2006). African indigenous leafy vegetables are key to the affordable and sustainable solution to the hunger and malnutrition menace in SSA. The ALVs contain higher nutritional benefits than the exotic ones. Abukutsa-Onyango, 2007; Kamga et al., 2013; Grivetti and Ogle, 2017). There is little work being done in South Africa to improve the genetics of *Solanum* nightshade. It is unclear whether the phenotype reflects genetic diversity. This study focuses on *Solanum* species, which are related to nightshades. There is little variation in the morphological, genetic and nutritional characterization of this species. The study hypothesizes that morpho-agronomic and nutritional attributes of different accessions of the same species grown under the same environmental conditions will not differ.

Materials and Methods

Nightshade accessions were evaluated in the field using a randomised complete block design with three replications over two growing seasons in 2019/2020 and 2020/21.

Results and Discussion

The tested Nightshade accessions showed considerable ($P < 0.05$) differences in morphological and nutritional traits, according to statistical analyses. The H' for all traits ranged from 0.00 to 0.227, indicating that there was little genetic diversity among the accessions tested. Morpho-agronomic traits for the first two principal components (PCs) accounted for 86.82%, while the first two components accounted for 74.61% of the total variation in nutritional traits, with Ca, Mg, Na, Zn, Fe, Al, N, K, and P contents contributing more to variability. Leaf area, stem diameter and total biomass were the major contributors to qualitative morphological variability components. The principal component biplots and cluster analysis among accessions revealed a significant level of variability.

Genetic parameters for quantitative morphological and nutritional traits were estimated and revealed a significant amount of genetic variability. For smallest leaf area, high genotypic coefficient variation (GCV), broadsense heritability (H^2), and genetic advance (GAM) was calculated (82.28 %, 70.59, and 142.40 %, respectively). For nutritional concentration a moderate H^2 with high GA was observed for Fe and Al resulting in high genetic gain at 5% selection intensity.

Conclusion

Nightshades with moderate-high genetic similarity and traits of interest can be selected and used in plant breeding to produce higher yielding and more nutrient-dense varieties. It is suggested that a breeding program for nightshades be constructed so that morphological characteristics can be migrated into the breeding process.

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Keywords:

Accession, Genetic advance, Heritability, Morphology, Nightshade, Nutrient

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Introduction:

Acid mine drainage (AMD) is associated with very low pH ranging from 2 to 4 in water. At this pH, the mobility of acid generating trace elements increases, resulting in a highly acidic mine water discharge. Using AMD for crop irrigation may cause leaf scorching. One possible means of addressing such leaf scorching may be to attempt to protect crops using anti-transpirants in early vulnerable development stages until they can tolerate acid waters.

Materials and Methods

Two glasshouse pot trials and a field trial were undertaken in the 2020/2021 season. Simulated AMD was prepared using concentrated sulphuric acid. All plants were exposed to AMD with pH levels of 2.0, 2.5, 3.0, 4.0 and 7.0. The first pot trial tested AMD on leaf scorching and the second focused on the effectiveness of Wiltpruf, an anti-transpirant, in protecting crops against leaf scorching. The field trial tested whether AMD will cause leaf scorching on selected crops. Experimental design was a split plot with pH as main plot treatment and crop species as sub-plot treatments.

Results and Discussion

Wetting leaves with AMD resulted in leaf scorching at pH levels of 2.0, 2.5 and 3. Injury was, however, low at 6% in worst affected crop species. Results also indicated that Wiltpruf significantly ($P < 0.05$) increased the propensity for foliar injury among crops, especially at pH levels of 2.0 and 2.5. The greatest injury percentage was 7.7 % at pH 2.0 where Wiltpruf was applied. Wiltpruf sealing stomata and impeding gaseous exchange may have reduced crops' natural defense against acid foliar damage. Chlorophyll content was not significantly affected by treatments. All parameters measured in the field trial; fractional interception of PAR, chlorophyll content and biomass were not significantly affected by foliar wetting with AMD. In addition, no signs of leaf scorching were identified in the field trial due to delay in onset of foliar wetting with AMD.

Conclusion

It is concluded that crops showed signs of scorching in the glass house trials with no injuries noted in the field trial. Treating crop seedlings with Wiltpruf prior to foliar wetting with AMD aggravated the incidence of leaf scorching. Given low levels of scorching, and ability of crops to recover as they grow, there appears to be little need to be concerned about scorching. Growth performance of control treatments that were treated with Wiltpruf were not affected by the anti-transpirant. Further research is needed to test the reasons behind Wiltpruf increasing the propensity of leaf scorching.

References

Keywords:

Acid mine drainage, anti-transpirants, foliar wetting, leaf scorching, pH level, wiltpruf.

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Introduction:

South Africa is classified as a semi-arid and water stressed country, with recurrent extremes of temperature and rainfall that affect agriculture (Kephe et al., 2021). The aim of this study was to analyze the trends in extreme temperature and rainfall in Koedoeskop (Limpopo) and Hartswater (North West) using RClimDex for the period of 1975-2020.

Materials and Methods

Weather data from 1975-2020 was obtained from the ARC-NRE for the Koedoeskop (30744) and Hartswater (19847) weather stations. Extreme indices were calculated using R code from RClimDex (Zhang & Yang 2004) that provides 27 indices recommended by Expert Team on Climate Change Detection and Indices (Zhang et al., 2011), however, only six indices were selected to reflect different aspects of extreme events in this study. The extreme indices computed were consecutive dry days, consecutive wet days, highest maximum temperature, lowest minimum temperature, warm days and cold days. Non-parametric Mann–Kendall tests and Sen's slope estimates were used to test the statistical significance and trend of each of the extreme indices.

Results and Discussion

In South Africa, barley is mostly grown in Northern Cape Province. It tolerates drought relatively well and can even grow in semi-arid areas with annual rainfall of 200-350 mm. From the analysis of temperature indices for Koedoeskop and Hartswater, the lowest value of daily minimum temperature in Koedoeskop and Hartswater went down to -5°C and -9°C respectively, this can cause poor germination in barley, which germinates at 1-3 °C. The optimum temperature for germination is 20-22 °C. However the seedlings can withstand frosts up to -8 °C, but during flowering and ripening, barley is very sensitive to frosts from -1.5 to -3 °C. The precipitation extreme indices showed that there was an increasing trend in the number of consecutive dry days for both sites from 2010 to 2020. The longest dry spell of more than 150 days was recorded in 2015 and 2016 at Hartswater and Koedoeskop, respectively. Trend in consecutive wet days showed a decreasing trend of seven to three days from 2005 to 2020 at both sites, which indicates that both sites are becoming relatively drier. The number of warm days increased from 12 to 40 days in Hartswater and 15 to 45 days in Koedoeskop from 2011 to 2020.

Conclusion

Both sites are undergoing climate change with decreases in cold days and increases in warm days. Furthermore, the study showed increasing trend in number of consecutive dry days evidencing that both sites are becoming drier.

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Keywords:

Extreme indices, Temperature, Rainfall, RClimDex software, Mann–Kendall test.

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Introduction:

Wheat (*Triticum aestivum* L.) production is threatened by the decline in agricultural land available due to urbanisation and industrialisation, climate change and environmental degradation. The aim of this study was to use long-term data and crop modelling to investigate ecologically intensified (EI) wheat production management practices in South Africa.

Materials and Methods

Data from the University of Pretoria's Hillcrest Campus Experimental Farm long-term wheat trial was used to guide the modelling. The APSIM model was parameterised using a wheat growth analysis conducted in 2019, and calibrated and validated using historical weather, soil and non-fertilised long-term yield data from 1950-2019.

Results and Discussion

The model performed well in simulating wheat yields and SOM for the zero and full NPK fertiliser treatments over 69 years. Long-term EI management scenarios including crop rotation, manure application, increased fertiliser application rate, objectively-scheduled irrigation, and combining all of the improved management practices together showed positive benefits in increasing wheat yields and reducing both deep drainage and N leaching. The adoption of all management practices simultaneously was simulated by the model to be the best practice in intensifying long-term wheat production, due to higher yields (an increase of 18%) with reduced deep drainage and N leaching (decrease by 31%). A steady loss of SOM (1.20 to 0.68%) could, however, not be prevented.

Conclusion

The use of long-term data and crop modelling has been demonstrated to inform improved management practices to improve yields while conserving natural resources and minimising environmental pollution. Innovative methods to maintain SOM still need to be identified.

Keywords:

APSIM-model, crop intensification, fertiliser, soil organic matter, wheat

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Introduction:

Agricultural activities are closely linked to the health of the soil, meaning that healthy soils should be able to provide healthy crops in a sustainable way. Since monoculture is so far removed from nature, rotational crops are often included to provide more biodiversity, a break in pest cycles and a diversity in farming risk. In 2006 an effort was made to determine the effect of monoculture versus crop rotation on selected microbial and physicochemical aspects in wheat fields. The original study lasted for four years and season seemed to be the biggest driving force in separating the measured microbial variables. Since the site had been managed in the same way as it was at the time of the original study, the site was visited again after 10 years and soil samples were taken in August of 2019. This was done in order to determine the long-term effect of the two systems on the soil physicochemical and biological parameters measured.

Materials and Methods

Composite soil samples were collected in mid-August of 2019, at the peak of the growing season in the Western Cape Province. The two treatments were wheat monoculture compared to wheat rotated with a medic/clover pasture. Some physicochemical as well as biological variables were measured. Carbon substrate utilisation was measured with Biolog Ecoplates TM in the original study as well as in 2019. Additional biological parameters were measured in 2019, namely active carbon (KmNO₄) microbial activity (FDA) and aggregate stability (wet sieving method).

Results and Discussion

The rainfall varied over the 14 years and this fluctuation seemed to have had an influence on the soil microbes. When all measured variables were subjected to discriminant analysis, it was clear that the two treatments (monoculture and rotation) had a significant influence on the measured soil microbial variables. These results indicate that the management practice – monoculture or rotation in this instance – had a significant influence on the soil microbial communities, but that it changed slowly over time.

Conclusion

Monoculture is not sustainable. Crop rotation is a viable option and has benefits for the cash crop as well as for the soil health.

Keywords:

microbial aspects, physicochemical aspects, soil health, wheat

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Introduction:

In-field yield variability of cropping systems has been extensively investigated (Maestrini and Basso 2018), but the spatial variability of crop yield response to agronomic inputs is often poorly understood (Trevisan et al. 2021). An opportunity to use precision agriculture equipment to understand in-field spatial variation and optimal input application rates in South Africa was investigated using the Data Intensive Farm Management (DIFM) approach (Bullock et al. 2019). Studying the site-specific relationships of seeding and fertilizer application rates is key to the evaluation of various ways to efficiently identify interactions between field characteristics and management inputs.

Materials and Methods

This precision agriculture approach utilizes the grower's GPS-guided variable seeding and nutrient application rate and yield monitoring equipment to run a data-driven science experiment on a commercial farm. The approach was tested for maize (*Zea mays* L.) in the north-eastern Free State during the 2019/2020 and 2020/2021 seasons. The 'status quo' nitrogen (N) fertilizer rate was 224 kg/ha and applications were varied from 106 kg ha⁻¹ to 303 kg/ha. Seeding rates were varied from 10 000 to 50 000 seeds/ha, with a status quo seeding rate of 18 000 seeds/ha. 'As planted' and 'as applied' maps were concatenated with yield maps to get 'experimental units' for the different combinations of inputs.

Results and Discussion

The results of this study demonstrated that the shape of yield response curves depends on field characteristics (various soil properties), whereby different parts of the field have different optimal seeding and N fertilizer rates. By estimating yield response, it was possible to estimate economically optimal planting and application rate strategies. The data indicated that implementing the recommended site-specific seeding strategy would result in an economic gain in each management zone.

Conclusion

The DIFM approach shows excellent potential for increasing farm profitability by spatially exploring the agronomic and economic responses of altering seed and fertiliser rates between zones in a field. More research on response-based input management recommendations, including the development of decision support systems, is encouraged by the findings of this research.

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Keywords:

Precision agriculture, spatial variation, management zones

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Introduction:

Maize is grown in most parts of South Africa and ranked as number one consumed primary crop. The timing of nitrogen application is an essential management decision for maize production. The aim of the study was to determine the effect of timing of nitrogen, cultivar and location on the growth performance of maize.

Materials and Methods

The study was carried out at Mafikeng and Taung in the North West Province in South Africa during 2019/2020 and 2020/2021 planting seasons. The nitrogen fertilizer applications were done at 0 nitrogen application, during planting, during emergence, during five leaf stage and during ten leaf stage at 49 and 63 (DAP). The two cultivars planted were early maturing (PAN 4A 111) and late maturing (PAN 413). The nitrogen fertilizer was applied at 120 kg/ha and the study was an irrigated research trial. The experimental design was 5 × 2 × 2 factorial experiment fitted in a randomized complete block design (RCBD) with four replications. The measured growth parameters were plant height, number of leaves, leaf area, chlorophyll content and stem diameter.

Results and Discussion

The timing of nitrogen fertilizer application had a significant effect ($P \leq 0.05$) on maize growth parameters at 49 and 63 DAP during 2019/2020 and 2020/2021 planting seasons. During 2019/2020 planting season, nitrogen fertilizer applied during planting, emergence and five leaf stage had significantly taller plant height, higher number of leaves and stem diameter at 49 and 63 DAP. During 2020/2021 planting season, nitrogen fertilizer applied during planting, emergence and five leaf stage also had significantly taller plants and higher number of leaves at 49 and 63 DAP. The higher growth of maize plants could have been attributed to the initial nitrogen availability at the beginning of growth and development of maize. Maize growth parameters at Mafikeng were significantly ($P \leq 0.05$) higher than maize at Taung. The better growth of maize at Mafikeng could have been attributed to prevailing favourable climatic factors such as rainfall and temperature during critical growth stages of maize.

Conclusion

The timing of nitrogen fertilizer application during planting, emergence and five leaf stage affected maize growth significantly. The study concludes that the application of nitrogen fertilizer at early growth stages of maize produces higher growth.

References

Keywords:

Timing of nitrogen, growth stages, Location

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Introduction:

Food production is critically connected to water availability, which is fast becoming scarce. Identifying cereal crops and varieties with high water use efficiency is critical because cereal crops are integral to food security. There are a few studies that comprehensively and simultaneously compared water use efficiency and biomass productivity of wheat, maize, sorghum and pearl millet.

Materials and Methods

A study was conducted to compare the water use efficiency of the different crop species under optimal and drought-stressed conditions. Data on water use efficiency was collected from different studies around the world from published papers. A total of 700 observations on water use efficiency and biomass production in wheat, maize, sorghum and pearl millet were compiled into a database and subjected to statistical analyses in Genstat and R software and the meta-effects of drought stress were calculated using MetaEasy software in Excel.

Results and Discussion

The means for biomass production of maize, sorghum, millet and wheat were 24.0, 18.4, 14.6 and 8.1 t ha⁻¹ under optimal conditions, respectively. Grain yield production followed a similar trend under drought conditions with maize attaining 8.2 t ha⁻¹ followed by sorghum (6.5 t ha⁻¹), millet (6.3 t ha⁻¹) and wheat (3.1 t ha⁻¹). The high biomass production potential of maize, sorghum and millet is supported by their C4 photosynthesis compared to wheat, which is a C3 crop. However, maize incurred 52% yield loss due to drought stress compared to wheat (43%), sorghum (26%) and millet (25%). The meta-analysis showed that drought effect size on yield production was -0.6 for maize and -0.55 for wheat, showing that these crops were highly sensitive to drought stress compared to millet (-0.30) and sorghum (-0.20). Again, sorghum and millet had higher water use efficiency, attaining more than 4.0 kg of grain m⁻³ of water used. In general, higher water use efficiency in crops was recorded under drought stress conditions. However, there was a negative association between water use efficiency and biomass traits.

Conclusion

In conclusion, sorghum and millet are recommended for water-constrained ecologies to maximize water use and food production. The intraspecific variation provides opportunities for selection and developing improved varieties

References

Keywords:

biomass production, commodity crops, drought stress, water availability, water productivity

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Introduction:

Intercropping system is one of the ancient sustainable crop production practices in areas with poor soil conditions due to efficient utilization of resources such as light and water. Grain sorghum and cowpea are important staple crops in many areas of South Africa, particularly the Limpopo Province. The two crops are produced under a wide range of unsustainable practices which reduce productivity in the long run. Literature indicated that with limited water intercropping improved water use efficiency of grain sorghum and cowpea. However, there is limited information on water use efficiency and water equivalent ratio of grain sorghum-cowpea intercropping system under distinct agro-ecological regions of Limpopo Province.

Materials and Methods

A no-tillage field experiment was laid out in a randomised complete block design (RCBD) with four replications over two seasons of 2018/19 and 2020/21 in two distinct agro-ecological zones, Syferkuil and Ofcolaco in the province to assess water productivity of sorghum-cowpea intercropping system. Four grain sorghum cultivars at a uniform density of 37037 plants/ha were intercropped with one cowpea cultivar at two densities of 37037 and 74074 plants/ha. The two crops were grown in sole and intercrop cultures. Evapotranspiration was estimated using change in storage, rainfall and irrigation. Water use efficiency was calculated by dividing grain yield with evapotranspiration.

Results and Discussion

The results revealed variation in evapotranspiration and water use efficiency of grain sorghum and cowpea in binary and sole cultures during both seasons. At Syferkuil, high density cowpea intercrop had about 20% higher water use efficiency compared to low density intercrop. However, At Ofcolaco cowpea had only 0.2% higher water use efficiency in low density compared to high density. Grain sorghum cultivars varied in water use efficiency in binary and sole cultures depending on density of cowpea, location and season. However, cultivar Enforcer was consistent at each location and across seasons with high water use efficiency when intercropped with high cowpea density with the means of 12.11 kg/ha mm and 7.07 kg/ha/mm at Syferkuil and 12.44 kg/ha/mm and 10.17 kg/ha/mm at Ofcolaco during 2018/19 cropping season. The total water equivalent ratios exceeded 1.0 at the two locations across seasons, ranging from 1.3 to 1.9.

Conclusion

From the results, it can be concluded that water was used more efficiently in sorghum-cowpea intercrop at both Syferkuil and Ofcolaco. Sorghum-cowpea intercropping system can be adopted as one of the climate-smart practices for sustainable production in Limpopo province.

References

Keywords:

Climate-smart agriculture, intercropping, no-tillage, water conservation, water equivalent ratio.

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Introduction:

Present and ongoing climate change have led to population decline in many species. Furthermore, severe drought may trigger a transition of vegetation composition in dryland grasslands, with productive perennial grasses often being replaced by annual grasses. Grazing pressure is thought to exacerbate drought effects, but little is known on the joint effects of grazing and drought on the functional and taxonomic composition of the herbaceous vegetation in African savannas. This study thus aimed to elucidate which herbaceous species and plant functional types (PFTs) are most resistant to prolonged drought and grazing, and whether resting plays a role in this context.

Materials and Methods

A six-year field experiment was performed in South Africa's Limpopo province, combining drought and grazing treatments. The DroughtAct experiment evaluates ecosystem functions and services from grazed and ungrazed vegetation, under drought and non-drought conditions. Aboveground herbaceous biomass was harvested annually and separated into species. Species were grouped into five PFTs, i.e. very broad-leaved perennial grasses, broad-leaved perennial grasses, narrow-leaved perennial grasses, annual grasses, and forbs. Furthermore, for all species, three leaf traits were recorded (leaf area - LA, specific leaf area – SLA, and leaf dry matter content – LDMC) to describe their resource acquisition strategies. Generalized linear models were used to test for treatment effects and their interaction. Moreover, association indices were used to detect the relationship between species and treatments.

Results and Discussion

There were no absolute winner species or PFTs, as the six-year severe drought had a pronounced negative impact on the biomass production of all species and PFTs. However, relative winners were detected with increases in relative abundances, mainly forbs and less palatable narrow-leaved grasses with comparatively low LA and high LDMC such as *Aristida stipitata* Hack. These species and PFTs also tended to be favoured by grazing. The relative significant effect of long-term drought as shown by the winner and loser species is distinct from what has been observed in prior long-term studies, most notably in African savannas.

Conclusion

Although few species profited from resting, for most species, the combination of drought and resting proved to be particularly unfavourable. Furthermore, the identification of relative winner and loser species strongly indicates significant shifts in both functional and taxonomic composition. Winners and losers can indicate ecological transition and may be used to guide management decisions. Therefore, conservationists and land managers need to identify species that are likely to be most vulnerable to the impacts of climate change.

Keywords:

Aboveground net primary production, plant functional types, leaf traits, taxonomic composition

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Introduction:

Grain legumes, including common bean are important to feed the growing world population, as they are cheaper and healthier food source (Ibny et al. 2018). This study assessed the nodulation of common bean by endemic Cape fynbos rhizobia which is naturally adapted to hot, acidic and nutrient poor conditions.

Materials and Methods

Rhizosphere soils were collected during the wet season, from natural stands of *Polhillia pallens*, *Wiborgia obcordata* and *Wiborgiella sessilifolia* at five different sites of the Cape fynbos. In the glasshouse, sterilised seeds of common bean were planted in pots containing sterile sand and inoculated with rhizosphere soil suspension from all the locations, with three replicates per treatment. The seedlings were supplied with N-free nutrient solution. Sixty days after inoculation plants were harvested and available root nodules were used to isolate rhizobia following standard procedures. Rhizobial isolates were studied for their genetic diversity and phylogeny using the ERIC-PCR and Multilocus Sequence Analysis (MLSA) techniques respectively. Isolates were also subjected to various stress conditions under YMA media.

Results and Discussion

The morpho-physiological studies revealed that the ten bacterial isolates were intermediate growers with different sizes and shapes. The isolates exhibited tolerance to salinity (0.5-3% NaCl), pH (pH 5-10), different antibiotic concentrations, and could produce 4.0 to 41.0 µg.ml⁻¹ of indole-3-acetic acid (IAA), as well as solubilize tri-calcium phosphate. The ERIC-PCR results showed genomic diversity among the ten isolates and grouped them into three major clusters with low similarities (≤25%). The 16S rRNA sequence data showed that the microsymbionts nodulating common bean formed one cluster with the reference strains of *Rhizobium leucaenae*. The results from sequencing the three housekeeping (*atpD*, *glnII* and *gyrB*) and symbiotic genes (*nifH* and *nodC*) of isolates TUTWCb6, TUTCCb8 and TUTWCb10, confirmed that common bean is a promiscuous host nodulated by *R. leucaenae* and *R. tropici* strains found in the Cape fynbos. The occurrence of horizontal gene transfer was also observed.

Conclusion

This study concludes that the Cape fynbos is a reservoir of genetically diverse rhizobia capable of nodulating non-endemic legumes including common bean. Isolate TUTWCb6, described as *R. leucaenae* species demonstrated high tolerance to high temperatures, acidity, antibiotics and P solubilizing as well as IAA production abilities under laboratory media. This isolate is recommended as possible candidate for inoculant s production and further studies on this isolate s will be useful.

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Keywords:

Housekeeping genes, Cape fynbos, Rhizobia, Common bean, Nodulation

SELECTING GROUNDNUT (ARACHIS HYPOGAEAE L.) GENOTYPES FOR HIGH PHOSPHORUS UTILIZATION EFFICIENCY IN LOW P SOILS UNDER FIELD CONDITIONS IN NORTHERN GHANA

Oral

Presenter: Titus Ngmenzuma (zuma.titus@yahoo.com)

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Introduction:

Nitrogen and phosphorus deficiency commonly limits crop growth and grain yield in global agriculture. Phosphorus is an essential nutrient required in macro-quantities for plant growth. It is a key component of nucleic acids, phospholipids as well as adenosine triphosphate (ATP) and is involved in the regulation of a large number of essential enzymes and metabolic pathways such as photosynthesis, respiration, N₂-fixation and energy transfer. Plants improve their P uptake efficiency through exudation of phosphatases among others. In grain legumes, higher acid and alkaline phosphatase activity in the rhizosphere is linked to high P accumulation in the plant shoot. The aim of this study was to evaluate Phosphatase Use-Efficiency (PUE) and the effect of P nutrition in three groundnut genotypes grown on low P soils in the Guinea Savanna of Ghana.

Materials and Methods

The experiments were laid out in a randomized complete block design with three replicates at each location. Seeds were sown with a 40 cm inter-row spacing and a 15 cm intra-row spacing. Plot sizes were 6 m² (3 m × 2 m). Each plot contained three rows with 15 plants per row. Rhizosphere soils and shoot were sampled from 40 locations in three regions of Northern Ghana during the flowering stage. In the laboratory, acid and alkaline phosphatases were analyzed in the rhizosphere soils following Tabatabai (1994). A 2-way ANOVA was used to analyze data using Statistica software package.

Results and Discussion

There were strong variations in P-enzyme activities in the rhizosphere of groundnut plants across the 40 different locations. APase activity ranged from 9.8 to 18.8 µg. g fresh wt soil⁻¹.h⁻¹ and AlkPase ranged from 7.3 to 9.6 µg. g fresh wt soil⁻¹.h⁻¹ in the Tolon district. However, in Yendi, the range was 20.5 to 31.8 µg. g fresh wt soil⁻¹.h⁻¹ for APase and 12.9 to 18.0 µg. g fresh wt soil⁻¹.h⁻¹ for AlkPase. In all eight districts studied, shoot biomass was significantly correlated with P-use efficiency and symbiotic P-use efficiency. These results are consistent with findings from previous studies (Inal, 2007).

Conclusion

There were strong genotypic differences in P uptake and utilization efficiency with genotype Samnut 22 exhibiting greater P-utilization efficiency. More field testing is required to explore the potential use of genotype Samnut 22 by farmers given its superior performance under low P soils.

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Keywords:

Phosphorus, Groundnut, Phosphatase activity, Guinea Savanna, Rhizosphere

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2	Dr. D. Marais	Main Supervisor
3	Prof. J.M. Steyn	Co- Supervisor

Introduction:

Rhizobium inoculation and seed dressing are some of the agronomic practices that affect crop productivity in doubled-up legume technology. Doubled-up legume technology is the practice of intercropping two compatible grain legume crops that have different root and shoot growth systems in a field in order to maximise land and crop productivity. A field study with groundnut and pigeon pea as test crops was conducted at Innovation Africa at University of Pretoria (IA@UP), South Africa during the 2020/2021 crop growing season to investigate the effect of inoculation and seed dressing on doubled-up legume technology.

Materials and Methods

The study involved twelve treatment combinations namely; Untreated sole pigeon pea (PP), Untreated sole groundnut (GN), Untreated PP-GN intercrop, Inoculated sole PP, Inoculated sole GN, Inoculated PP-GN intercrop, Seed dressed sole PP, Seed dressed sole GN, Seed dressed PP-GN intercrop, Inoculated + Seed dressed sole PP, Inoculated + seed dressed sole GN, Inoculated+ Seed dressed PP-GN intercrop with one control (Untreated PP-GN intercrop) and each treatment was replicated three times using a randomized complete block design (RCBD). Parameters assessed included soil analysis, germination and survival %, Rhizobium and plant growth parameters, yield and land equivalent ratio.

Results and Discussion

Grain yield for both groundnut and pigeon pea indicated that treatments had a significant ($P < 0.05$) effect on grain yield. Furthermore, some sole treatments produced higher grain yield for both groundnut and pigeon pea than for the respective intercropped treatments. The sole treatments for both groundnut and pigeon pea receiving both inoculation and seed dressing produced outstanding grain yields (2451 kg ha⁻¹ and 2340 kg ha⁻¹ respectively), as compared to both sole crop treatments. For intercropped treatments, the inoculation and seed dressing treatment outperformed other treatments in terms of survival %, nodule efficiency and grain yield. Based on productivity, except for the untreated intercrop, all other intercropped treatments were more productive than their respective sole treatments.

Conclusion

Groundnut–pigeon pea intercropping (doubled-up) with both Rhizobium inoculation and seed dressing was the best treatment since it resulted into higher land equivalent ratio (1.7054) and grain yields for both crops than any of the other intercropped treatments.

Keywords:

groundnut, land equivalent ratio, pigeon pea and rhizobium

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Introduction:

National weather services forecast town/city daily minimum air temperature one to five days ahead. These forecasts are not field-specific for frost prediction. For agricultural operations, weather forecasts cannot be relied upon for all locations of the forecast area due to topographical/vegetation variability (Wu et al. 2011).

Prediction of site-specific daily minimum canopy and air temperatures, typically 1 to 6 h before sunrise, would be beneficial to agriculture and human activities. Nowcasting refers to short-term weather forecasts a few hours before the predicted event. Dynamic nowcasting refers to regular nowcasts.

Savage (2016) developed site-specific nowcasting procedures (Parton and Logan 1981; Snyder and de Melo-Abreu 2005). The nowcasts, 2 and 4 h before sunrise, were for daily minimum air/grass temperatures based on automatic weather station sub-hourly temperature measurements.

There is however no known simple methodology for dynamic nowcasting (hourly), for the combat of frost (Savage, 2012), of daily minimum canopy or air temperatures after midnight. A notice period of 1 to 6 h could give the farmer sufficient time for combating frost measures to be implemented.

The aim of this work was to assess the accuracy of hourly (night-time) dynamic nowcasts based on sub-hourly canopy orchard and air temperatures.

Materials and Methods

Sub-hourly canopy and 2-m air temperatures (15-min) from an avocado (Hass) orchard (1994-1996) in Howick, KwaZulu-Natal and Marianna, Florida, USA were used. Air temperatures at 0.6 m for 2004 for Marianna were used for dynamic nowcasts.

Results and Discussion

The 2- and 4-h ahead-of-sunrise nowcasts, using night-time (exponential and square root) models, and the 1 to 6 am dynamic nowcasts, are presented.

For 2-h ahead-of-sunrise nowcasts, the comparisons yielded similar coefficient of determination values and smallest root mean square (RMSE) compared to the square root model. Slope values were not different from 1 at 95 and 99 % levels of confidence. The 4-h ahead canopy temperature nowcasts were more variable than for 2-h ahead for the exponential and square root models, with reduced coefficient of determination and increased RMSE.

For the canopy temperature dynamic nowcasts, there were decreases in RMSE between 1 and 6 am (3.47 to 1.38 oC respectively).

Conclusion

Dynamic nowcasting modelling allowed for hourly nowcasts of minimum canopy temperature. This results in a 1- to 6-h notice period of possible frost occurrence and its combat.

Hourly dynamic nowcasts during the frost period could be displayed on a web-based system (Savage et al. 2014) and sms'ed, to interested parties, directly from the datalogger.

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Keywords:

Diurnal temperature modelling; early warning of minimum temperature; frost; hourly nowcasting; sub-hourly temperatures

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Introduction:

Red leaf blotch (*Phoma glycinicola*), frog-eye leaf spot (*Cercospora sojina*), bacterial pustule (*Xanthomonas axonopodis* pv. *glycines*) and soybean rust (*Phakopsora pachyrhizi*) are diseases of economic importance in soybean production (Mutithi et al., 2016). Studies on the effect of mentioned diseases have not been intensively carried out hence their effect is not fully known. The objective of this study was therefore to determine the contribution of each disease to reduction of soybean growth and yield so as to influence disease management decision for communal farming.

Materials and Methods

The trial was laid in RCBD design with treatments arranged in a split plot replicated four times. The trial was conducted in Hurungwe over two growing seasons, 2016 and 2017. Two commercial soybean cultivars 'Solitaire' and 'Storm' and a local cultivar 'Hurungwe special' were planted in both seasons at three planting dates, 15 October, 15 December, and 15 January. Soybean severity screening was initiated one week after first symptoms observed, after which weekly screenings were conducted for a period of five weeks using a rust rating scale. Frog-eye leaf spot, red leaf blotch and bacterial pustule were assessed at two week interval starting from two weeks after first symptoms were observed until the plants reached physiological maturity. The relationship between two data were compared using correlation coefficient. It tests whether large values of one set are associated with large values of the other (positive correlation), whereas small values of one set are associated with large values of the other (negative correlation), or whether values in both sets are unrelated (correlation near zero).

Results and Discussion

Natural disease infestations of red leaf blotch, frog-eye leaf spot and bacterial pustule, were observed in both seasons, with soybean rust only reported in the first season. Correlation analysis between yield and disease severity indicated that of the four diseases, soybean rust was the one that had a significant effect on the yield. This correlation between soybean rust and yield was negative and highly significant ($P \leq 0.01$) for the first season. The interaction between planting date and cultivar had a significant effect on soybean rust and bacterial pustule contributing 10 and 5% in total treatment variation (TTV), respectively, for the first season, only bacterial pustule was significantly affected by the interaction in the second season contributing 15% in TTV.

Conclusion

Soybean rust is a key soybean disease therefore most management decisions must be focused on its management.

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Keywords:

Disease complex, disease severity

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Introduction:

Maize (*Zea mays* L.) is a staple crop for most countries in Southern Africa. In South Africa, it is the predominantly produced cereal crop covering about 58% of the cropping area (Adisa et al. 2018). With an increase of world population, farmers rely more on synthetic fertilizers to maximize their yields. However, fertilizers also promote weed infestation thus increasing competition for growth and resources (Jiang et al. 2018). The study hypothesized that balanced nutrition will result in higher weed abundance and diversity.

Materials and Methods

The study was carried out in a long-term maize fertilizer trial at the University of Pretoria to assess the effect of inorganic fertilizer combinations on weed abundance and diversity. The trial had eight treatments at set rates for all treatment combinations, namely; the control, N, P, K, NP, NK, PK and NPK laid out in a RCBD with four replications. The herbicide glyphosate was applied three weeks after emergence of the maize at a rate of rate of 3l. ha⁻¹. Data was generated through the quantitative analysis of weed cover, weed biomass, weed density, relative abundance and relative diversity using SAS software (version 9.4) and means were separated using LSD test at 5% level of significance.

Results and Discussion

For both seasons (2018/19 and 2019/2020), results showed marked differences for weed cover, weed density and weed biomass between the treatments. There were variations between the tested treatments amongst the growing seasons which could have been affected by climatic conditions, soil nutrition status, spatial and temporal variation. *Tagetes minuta* and *Galinsoga parviflora* were most dominant in NPK, N and NK fertilized plots. In the first season, higher diversity was observed in PK, K, NPK, P and control. In the second season, NPK, P and PK treatments had high weed diversity and it was observed that weeds differed substantially in different fertilizer regimes

Conclusion

Competition for nutrients, moisture and sunlight within weeds, and between weeds and maize probably influenced the population of weeds. An integrated weed management system can therefore be recommended for maize production as some weeds tend to germinate later within the season.

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Jiang M, Liu T, Huang N, Shen X, Shen M, Dai Q. 2018. Effect of long-term fertilisation on the weed community of a winter wheat field. *Scientific Reports* 8: 1-7.

Keywords:

abundance, competition, diversity, fertilizers, weeds

Presenter: Mr Rens Smit (renss@elsenburg.com)

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Introduction:

Cover crops have the potential to improve current conservation agriculture cropping systems. This might achieve improved soil conditions, better nutrient recycling and possible improved yields and grain quality. The aim of this two year study was to compare the effect of different cover crop mixtures and three management strategies on the yield and quality of wheat grown in the following year.

Materials and Methods

Two cover crop mixtures (mainly legume and mainly cereal) were subjected to three management strategies. Each of the two mixtures were subjected to either mulching, haying or high intensity grazing. Wheat was planted into the residues the following year (2017 and 2018). Wheat yield and quality was compared between the different strategies. The experimental design was a randomised block design with four replications and the treatment design was a split plot with crop as main plot factor and management practices as subplot factor. The data were subjected to analysis of variance using the General Linear Models Procedure (SAS software Version 9.4). Fisher's least significant difference was calculated at the 5% level to compare treatment means.

Results and Discussion

Wheat yields were not affected ($p > 0.05$) by cover crop type or management. Wheat protein increased ($p < 0.05$) in 2017 following the mainly legume mixture compared to the mainly cereal mixture. This may be due to the larger portion of legumes in the mixture which are able to fix nitrogen. Irrespective of cover crop type grazing had the highest ($p < 0.05$) protein content in terms of cover crop management in both 2017 and 2018. Increased protein content of wheat besides nutritional benefits has the potential of increasing profitability of wheat production. Protein content of wheat is the main factor determining the first three grades of wheat. Increasing the protein content of wheat can increase the price of wheat. Nitrogen fertiliser use can be decreased because nitrogen is normally applied in order to increase the protein content of wheat.

In terms of all the other quality measurements hectolitre mass was the only parameter influenced. Wheat following grazed cover crops had a lower ($p < 0.05$) hectolitre mass (82.2 kg) in 2018 but not ($p > 0.05$) in 2017. The hectolitre mass, although reduced in 2018 after grazing, is still sufficient.

Conclusion

Grazing cover crops and legume cover crops both increased the protein content of wheat. This can be attributed to increased nitrogen availability for wheat. These improvements can improve the profitability of wheat production while providing additional fodder.

Keywords:

Conservation agriculture, protein, grazing

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Introduction:

Rain-fed agricultural production systems based on conservation agriculture principles has shown great benefit in sustainable production in the Swartland. Systems that include animals outperform cash crop systems. This study (2009 -2015) compares the growth rates of two sheep breeds within 4 different pasture crop rotation systems and explores a possible correlation between the sheep performance and subsequent wheat production.

Materials and Methods

South African Mutton Merino (SAMM) and Dohne Merino (DM) were compared over a six year period. The two breeds grazed the annual legume pastures on the long-term conservation agriculture trial at Langgewens Research farm, in the Swartland. Growth rates of the two types were determined by weighing the sheep monthly over the pastures grazing season in each of the four pasture crop systems. The experimental design was a randomised complete block design with 2 replications and 4 systems over six years. Due to limited repetitions the systems or years were combined. The data were subjected to analysis of variance or repeated-measures ANOVA was performed when responses were repeated on the same respondent over years using the General Linear Models Procedure. Fisher's least significant difference (LSD) was calculated at the 5% level to compare treatments. Pearson product moment correlation was performed using the Correlation Procedure. The two breeds, differences between systems and possible correlations between sheep performance and subsequent wheat yield were analysed and compared.

Results and Discussion

The two sheep breeds had similar ($p > 0.05$) growth rates irrespective of cropping system and years. The smaller framed DM sheep with lower maintenance costs and superior wool compared to SAMM. This indicates that DM will outperform SAMM under these conditions.

Cropping system had an effect ($p < 0.05$) on the growth of SAMM but not ($p > 0.05$) on DM. The larger frame SAMM may have required more fodder and the limited supply of fodder in some of the cropping systems may have slowed down their growth.

In one of the cropping systems (alternating medic pasture and wheat) wheat protein correlated ($r = 0.62$) with the previous year's growth rate of sheep ($p < 0.05$). The legume pasture which provide sheep with fodder correspondingly fix nitrogen.

Conclusion

Dohne Merino outperform SAMM in the Swartland under various integrated livestock and cropping systems. The growth rates of sheep can be influenced by different cropping systems but it is dependent on sheep breed.

References

Keywords:

Dohne Merino, South African Mutton Merino, Legume Pasture

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Introduction:

The atmospheric CO₂ concentration has increased by 120 ppm over the past 250 years and may reach 550 ppm by 2050 and 1000 ppm by 2100. Increasing CO₂ directly affects growth of C3 species such as potato through photosynthetic stimulation and reduced stomatal conductance (Steyn et al 2016; Tausz-Posch et al. 2020). Increased atmospheric CO₂ concentration is coupled with simultaneous rise in global temperatures. This will greatly affect plants (Gray and Brady 2016), as heat stress will likely reduce yields of heat-sensitive crops, although elevated CO₂ may ameliorate the heat stress somewhat (Pan et al. 2018). In South Africa, potatoes are often produced under unfavourable conditions, resulting in heat stress that negatively affect productivity. The study aim was to investigate the combined effects of elevated temperature and CO₂ to assess how climate change will affect potatoes in future.

Materials and Methods

A study was conducted over two seasons in growth chamber facilities of Innovation Africa at University of Pretoria (IA@UP). The 2x2x2 factorial study investigated two cultivars (Mondial, new and BP1, old cultivar), two levels of CO₂ and temperature (ambient or elevated): aCO₂=415 ppm, eCO₂=700 ppm and aT=12/25oC day/night, or eT=15/38 oC. Gas exchange measurements (using a Li-COR 6800 photosynthesis system,) and destructive growth analyses were conducted at five times during the season. Tuber fresh and dry yields were determined at final harvest. The data was subjected to analysis of variance using the statistical software package R. Means were separated for significance using Fisher's protected least significant difference test at p<0.05.

Results and Discussion

Elevated CO₂ resulted in higher photosynthetic rate, lower transpiration and higher biomass yield, which culminated in more than 100% tuber yield increases. Elevated temperature increased photosynthesis, stomatal conductance and transpiration, but suppressed haulm and tuber mass. Plant exposure to both elevated CO₂ and temperature (eCO₂ eT) resulted in significant yield increases, but yields were substantially lower than for the eCO₂aT treatment, illustrating that higher temperatures partly eroded the benefits of eCO₂. Mondial generally yielded higher than BP1, but both cultivars responded similarly to CO₂ x T treatment combinations.

Conclusion

The study confirms that elevated CO₂ will likely benefit potato yields in future. However, simultaneous increase in CO₂ and temperature will counteract this benefit. Therefore, cooler production regions of the country can likely expect significant yield increases in future, while already warm to hot regions may expect levelling off, or even a drop in yields due to heat stress.

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Keywords:

climate change, gas exchange, yield increase

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Introduction:

Rain-fed agricultural production systems based on conservation agriculture principles have shown great benefit in sustainable production in the Swartland. Crop diversity and sequence can play an important role in the changes to soil, yield and economics of rotation systems. The aim of this study was to evaluate the effect of 28 5-year cropping sequences on cation exchange values, soil carbon, wheat yield and sequence gross margin.

Materials and Methods

The base trial consist of three 10-year rotation systems with varying diversity in crops. All crops of each system is present every year and thus the first 5 years have a total of 28 different sequences with 4 repetitions each. Average cation exchange and soil organic carbon content were determined for each sequence, while the average wheat yield was obtained from the years when wheat occurred in the sequence. The average gross margin was determined from the values for each crop in the different sequences. The experimental design was a randomised (complete) block design (RBD/RCBD) with 4 replications and 28 crop sequences. The data were subjected to analysis of variance (ANOVA) using the General Linear Models Procedure (PROC GLM) of SAS software (Version 9.4; SAS Institute Inc, Cary, USA). Fisher's least significant difference (LSD) was calculated at the 5% or 10% level to compare treatment means.

Results and Discussion

Significant differences in sequences were noted in the ANOVA of the wheat yield and average gross margin parameters. Although no significance was shown in the ANOVA for the t-value and soil carbon analysis, sequence differences were noted in an unprotected Fisher t test with LSD. No single sequence appeared in the top 5 of all 4 parameters tested. One sequence (wheat/barley/canola/cover crop/faba bean) was featured in the top five sequences of all the parameters except average gross margin. None of the top sequences in average gross margin were featured in the other three parameters top five. Four of the top 5 average gross margin sequences included a single cover crop.

Conclusion

From the data it is interesting to note that there was more similarity between the crop sequence results in the average wheat yield, cation exchange value and soil carbon compared to average gross margin. Eighty percent of the top five average gross margin sequences included a single cover crop in a 5 year period. Diversity had the most pronounced effect on the cation exchange and soil carbon content.

Keywords:

conservation agriculture, gross margin, soil carbon, t-value, wheat yield

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3	Pieter Andreas Swanepoel	Stellenbosch University
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5	James Bennett	Coventry University (UK)

Introduction:

Intensive tillage can intensify soil degradation, whereas no-tillage can improve soil quality. Nonetheless, prolonged no-tillage can, inter alia, increase weed and insect pressure. Farmers who practise no-tillage are forced to apply synthetic agrochemicals (herbicides and insecticides) to control weeds and insects, which may lead to the development of herbicide-resistant weeds, kills beneficial insects, and harm humans. There is a need to convert current farming systems to become environmentally friendly by reducing reliance on synthetic agrochemicals. This study aimed to determine the effects of tillage practices on wheat (*Triticum aestivum*) and canola (*Brassica napus*) yield and quality in a dryland crop rotation system that received varied rates of synthetic agrochemicals. It was hypothesised that infrequent tillage practices will maintain/improve crop yield and quality whilst using a reduced quantity of synthetic agrochemicals

Materials and Methods

Effects of tillage and varied rates of synthetic agrochemical applications on crop productivity and quality (grain protein content, hectolitre mass, and seed oil content) were assessed between 2018 and 2020 in South Africa's Mediterranean climate zone. Seven tillage treatments were investigated: continuous mouldboard (MB) ploughing to a depth of 200 mm, tine-tillage (TT) to 150 mm, shallow tine-tillage (ST) to 75 mm, no-tillage (NT), and infrequent tillage treatments: ST conducted once in two years (ST-NT), ST conducted once in three years (ST-NT-NT), and ST conducted once in four years (ST-NT-NT-NT). Three rates of synthetic agrochemical applications were; standard (as applied in conservation agriculture), reduced (half of the agrochemicals applied in 'standard' are replaced with biochemicals), or minimum (one application of herbicide and nothing else). Herbicides were used for weed control.

Results and Discussion

Compared to NT, the infrequent tillage, and MB treatments did not reduce ($P>0.05$) grain/seed yield. In the systems with standard, and reduced synthetic agrochemicals, there were no differences ($P>0.05$) in wheat grain or canola seed yield in four of the seven tillage treatments in 2018, five out of seven in 2019 and three out of seven in 2020. Although not significant, infrequent tillage practices were in some cases more effective than NT at preventing yield or quality reductions resulting from reduced agrochemical application. It is therefore possible to reduce the applications of synthetic agrochemicals on the farms.

Conclusion

Infrequent tillage practices did not reduce grain yield or quality compared to NT in systems with reduced synthetic agrochemical application. We recommend that farmers opt for NT or infrequent tillage and avoid intensive tillage when applying a reduced quantity of synthetic agrochemicals.

References

Keywords:

Infrequent tillage, crop yield, tillage sequence, no-tillage, agrochemical

Presenter: Dr Jacques van Zyl (jacquesvz@elsenburg.com)

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Introduction:

Tillage plays a major role in modification of soil structure as it influences the distribution of energy rich organic matter within the soil profile. The aim of this study was to evaluate the effect of conservation farming practices on potato quality and yield as well as the effect on the physical, biological and chemical status of the soil.

Materials and Methods

Three tillage treatments were investigated. It consisted of a conventional tillage treatment with a mouldboard plough to a depth of 350 mm combined with a rip treatment 600 mm deep between planting rows, a conservation rip treatment to a depth of 600 mm between planting rows and a conservation paraplough treatment over two planting rows to a depth of 600 mm.

The cover crop combinations were black oats and rye planted after potato harvest and left for three years until the planting of potatoes thereafter. The third treatment was rye after harvest and then the establishment of triticale in the winter before the next potato planting.

Results and Discussion

High numbers of free living nematodes were present before planting and ranged between 937 and 273 nematodes per 250 cm³ of soil. The plant parasitic nematodes extracted were rootknot, lesion and spiral nematodes at lower than threshold densities. The soil biological activity was significantly higher in all the paraplough treatments. Soil carbon levels were significantly higher in the paraplough treatment compared to the conventional treatment and ranged between 0.173 to 0.237% carbon in the soil. No yield reduction was observed between conventional mouldboard and paraplough tillage treatments. The size distribution and overall quality were not negatively influenced by a specific tillage treatment. The soil compaction, up to 10 cm deep, was not influenced by tillage treatment, while the 20 and 30 cm depths showed that the paraplough treatment led to the most compacted layers at these depths. At 40 and 50 cm depths no significant differences were found regarding compaction. At 60 to 80 cm deep, the paraplough treatment showed the lowest soil densities. Black oats resulted in the lowest cover percentage and no weed problems were encountered in this study.

Conclusion

The general assumption that the conservation tillage influences quality and yield negatively did not materialise and in fact it was on par or even better than the conventional tillage treatment. Even if only some of the proposed changes in production methods are implemented, it will result in beneficial outcomes for soil dynamics.

References

Keywords:

Biological activity, compaction, cover crop, nematodes, potatoes

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4	Dr. PA Swanepoel	1 Department of Agronomy, Stellenbosch University

Introduction:

Weed management has become increasingly challenging in conservation agriculture as continuous heavy reliance on chemical herbicides leads to herbicide resistance. Alternative methods for weed suppression are required. Cover crops can be used as an integrated weed management method when the cover crop mixture is designed to compete with weeds. The aim of the study was to investigate the productivity of cover crops mixtures and the productivity of wheat following the year where weeds were managed with various cover crop mixtures.

Materials and Methods

A trial was established in 2019 on Langgewens Research Farm, Western Cape. Initially the area was cleared with herbicide and planted with ten cover crop mixtures and two controls (wheat and fallow). Seventeen cover crop species made up the 10 mixtures. Each mixture contained two or more cover crop species. At cover crop termination, by means of rolling, biomass production and botanical composition of the cover crops and weeds were quantified. Mixed models were used to test for differences between treatments. In 2020, wheat was planted over all cover crop plots at a seeding rate of 65 kg ha⁻¹ with 5.3 kg ha⁻¹ nitrogen. Wheat yield and botanical composition were determined at harvesting. No herbicides or additional nitrogen were used during the growing seasons.

Results and Discussion

In 2019, cover crop treatments differed in biomass production and ranged between 1.8 and 5.8 t ha⁻¹. The fallow control produced less ($p < 0.05$) biomass than all other treatments, excluding ($p \geq 0.05$) the most diverse mixture. Compared to the fallow control, all cover crop treatments significantly reduced and ($p \geq 0.05$) suppressed the growth of weeds. In 2020, wheat yields varied from 2.1 t ha⁻¹ in the most diverse mixture to 4.1 t ha⁻¹ in the rye, vetch and lupin mixture. Volunteer cover crop biomass varied from 0.2 to 5.0 t ha⁻¹, while weed biomass varied from 47.3 to 832.0 kg ha⁻¹, both indicating significant competition with the wheat crop. The rye, vetch and lupin mixture had amongst the lowest volunteer cover crop and weed biomass, while the most diverse mixture had amongst the highest volunteer cover crop and weed biomass. This explains the variation in wheat yield.

Conclusion

Volunteer cover crops competed with wheat because 2019 cover crops were able to mature and produce viable seed. There is potential for the use of cover crops for weed management, like the rye, vetch and lupin mixture. Management, however needs to be improved to prevent seed set from the cover crop species.

Keywords:

botanical composition, competition, yield

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3	CF Reinhardt	1. South African Herbicide Resistance Initiative, Enterprises UP, University of Pretoria, Pretoria, South Africa 3. Unit for Environmental Sciences and Management, North-West University, Potchefstroom, South Africa

Introduction:

The *Amaranthus* genus contain about 75 species, with some grouped into species-complexes because of difficulty to distinguish them morphologically and even on a genetic level. These species are broadly divided into weedy, grain and leafy or vegetable amaranths. Globally herbicide resistance has been reported in 11 different *Amaranthus* species with some populations showing multiple resistance to up to six different herbicide target sites. In 2018 we confirmed the first population of *Amaranthus palmeri* in South Africa (Sukhorukov et al 2021). Analysis confirmed the presence of multiple herbicide resistance traits in this population. Additionally, reports of herbicide resistance in *Amaranthus hybridus* have also been investigated and confirmed.

Materials and Methods

Leaf and seed samples were collected from *Amaranthus* plants from different locations in the Northern and Eastern Cape, Kwa-Zulu Natal and Limpopo provinces. Species identification were done through genetic barcoding using the 16s ITS region. Additionally, genetic profiling of herbicide resistance genes for three herbicide mode of actions (EPSPS, ALS and PPO) were performed to identify possible target site mutations. Greenhouse studies conducted at the University of Pretoria as well as in collaboration with Bayer (Germany) further characterized the herbicide resistance profiles based on dose response curves against these herbicide targets.

Results and Discussion

Herbicide resistant populations of *A. palmeri* and *A. hybridus* have been identified in three provinces (NC, EC and KZN). The resistance status of two additional populations of *A. palmeri* in Limpopo and one population of *A. hybridus* in the Free State still need investigation. Two different EPSPS resistance mechanisms (target site mutations as well as gene amplification) have been confirmed. These mechanisms differ between populations in the NC and KZN (Reinhardt et al., 2021). Similar EPSPS mutations were identified in *A. palmeri* and *A. hybridus* populations in KZN which might indicate transfer of resistance through hybridization. Mutations conferring resistance to ALS inhibitors were also detected in both species.

Conclusion

The increasing number of cases of single as well as multiple herbicide resistance populations of *Amaranthus* species in South Africa pose a significant risk to crop production, especially in glyphosate resistant maize, soybean and cotton cropping systems. These *Amaranthus* populations should be closely monitored and managed to prevent their spread and limit the impact on crop production. The possibility of hybridization between *Amaranthus* species further increase the risk of spread of herbicide resistance genes between populations and should be closely monitored.

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Keywords:

Amaranthus, herbicide resistance, weeds, EPSPS, ALS

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Introduction:

Climate change and variability negatively affect farming systems in South Africa. Climate-smart agriculture (CSA) interventions can address this, however, studies show that extension practitioners (EPs) do not know these technologies. A pilot training programme for EPs addressed knowledge and skills gaps in CSA technologies, being funded by GIZ, DFFE and DALRRD.

Materials and Methods

Application criteria included registration with SACNASP, gender balance, concept note about climate challenges, and balance across three provinces (Eastern Cape, Limpopo, North West). CSA manuals for each course were prepared by Agricultural Research Council researchers and reviewed by GIZ, DFFE, and DALRRD before inclusion in the e-Book. Courses for natural resources, field crops, piggery and poultry were offered in-person in each province starting in February 2020. However, due to COVID-19 restrictions, training was postponed, until mid-2021 under a mixed presentation mode with in-person and virtual courses. EP submitted three assignments, the final being a self-made video, about farmers applying these technologies, being graded according to a rubric (presentation, content, facilitation). The foundation course was on climate and natural resources, followed by two courses on crop production (summer, small grains and legumes; vegetables and subtropical fruits) and two on livestock production (beef, dairy, small stock; pigs and poultry), covering all aspects of CSA from breeding, nutrition, pests and disease management. An additional elective was on aquaponics.

Results and Discussion

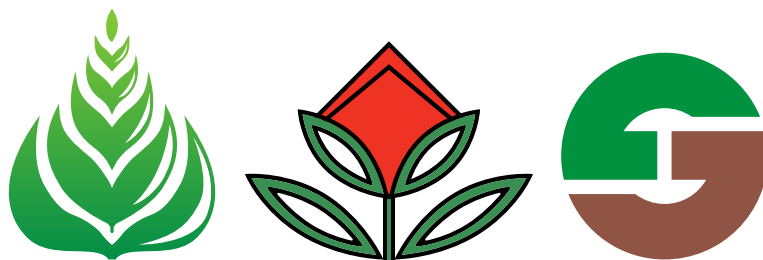
Overall gender balance was achieved (47 female, 54 male), although Limpopo had 23 females, and only EC had females over 50 years. A total of 101 EPs attended at least 15 days of training, either in person or virtually. All EPs completed the two written assignments of a situation analysis and CSA technologies addressing climate change. EPs (75%) submitted their CSA videos for assessment by the ARC core team to receive a completion certificate and CPD points. The videos were of a wide range of quality and useful content, consequently only selected high-quality scientifically correct videos are loaded to the CSA Toolkit. Many videos were about mulching, as an easily applied intervention to reduce water loss from the soil. EP completed evaluation forms after each course, that generally show they did learn about climate change interventions, are mostly confident or very confident to apply these techniques, and are satisfied or very satisfied with the training received.

Conclusion

Due to its success, the recommendation is to roll out this CSA training nationally to benefit EPs in the other six provinces and to others in these three provinces.

Keywords:

climate change, adaptation interventions, virtual training, crops, livestock



COMBINED CONGRESS

Annual congress of
SSSSA, SASHS & SASCP

Abstracts

Poster presentations:
Crop Science
(SASCP)

Presenter: Mr James Arathoon (james.arathoon@kzndard.gov.za)

Author(s)

#	Name	Affiliation
1	Mr James Arathoon	KwaZulu-Natal Department of Agriculture and Rural Development

Introduction:

KwaZulu-Natal small-scale farmers are unfamiliar with growing soybean (*Glycine max* L. Merrill). For the adoption of soybean by small-scale farmers, the crop has to be integrated into their farming systems, which include intercropping. The planting pattern in intercropping is among the factors that have a profound effect on yield, as it permits a planned sharing of natural resources (Undie et al. 2012). A four-year study was conducted at the Cedara Research Station, KwaZulu-Natal, to evaluate the effect of six cropping patterns on the yield of maize and soybean in the 2014/15, 2016/17, 2017/18 and 2018/19 growing-seasons.

Materials and Methods

The study design consisted of six crop arrangements in a completely randomized block with three replicates. The arrangements were four intercropping patterns and two monocultures (maize and soybean). The crop arrangements were sole maize (SM), sole soybean (SS), one row of maize to one row of soybean (1M:1S); two rows of maize to one row of soybean and two rows of soybean to one row of maize (2M:1S; 2S:1M), and two rows of soybean to two rows of maize (2M:2S). Maize and soybean were planted at 44 444 and 266 000 seeds/ha, respectively. The yields were determined and subjected to ANOVA ($p \leq 0.05$).

Results and Discussion

Significant interactions were measured for the yield of maize and soybean between the growing-seasons and cropping patterns. In the 2014/15, 2016/17, and 2018/19 growing-seasons, and overall, sole maize produced significantly higher yields (mean = 8.23 t/ha) than the intercropping patterns. However, in the 2017/18 growing-season the maize yield of 1M:2S was not significantly different to sole maize. Overall, the mean maize yield of the intercropping patterns was 68.0% of the yield of sole maize. Sole soybean (mean = 3.98 t/ha) produced significantly higher yields than the intercropping patterns in all four growing-seasons. The mean soybean yield of the intercropping patterns was 35.3% of sole soybean. This result was due to the effect of shading and competition for light, water and nutrients.

Conclusion

Intercropping resulted in the grain yield of the maize plants to increase, but the yield of soybean plants to decrease. The results indicate that sole cropping produces higher yields per unit area than intercropping.

References

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Keywords:

competition, crop arrangement, integration, monoculture, small-scale farmers

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Introduction:

Nitrogen is one of the growth and yield limiting factors of crop production. Legumes have the ability to fix atmospheric nitrogen into plant available nitrogen. The nitrogen is also available to the crop following the legume. The problem however is that the amount of nitrogen fixed by the different legumes is unknown in the Western Cape context. This is also the case with the amount available to the following crop. The aim of this study is therefore to quantify nitrogen fixing potential of specific legumes and their effect on the following cash crop.

Materials and Methods

Ten legume crops consisting of a faba bean, four lupins, a chickpea and four field peas were established at Langgewens and Riversdale in a randomised block design with 3 replications. The yield of the legumes was determined at the end of the 2020 growing season. Soil samples were taken at the start of the 2021 growing season on each plot and the available total nitrogen was determined. The available nitrogen was determined by measuring available ammonium and nitrate in the soil samples. This was done for the depths of 0-150 mm and 150-300 mm. This is preliminary data from the first year of a 4 year project.

Results and Discussion

The legume yield results differed significantly at Riversdale ($p < 0.01$), this was also true for Langgewens. The crop with the highest yield at Riversdale field pea although it did not differ from one of the lupin and fababean cultivars. The legume with the highest yield at Langgewens was the field peas. At Riversdale the soil nitrogen content ranged between 66 mg/kg and 98 mg/kg available for the following crop and between 50 mg/kg and 68 mg/kg at Langgewens.

Conclusion

The yield and the amount of nitrogen fixation was different between the different locations. This study will continue for the next two years to study the effect of the legumes over a longer period to get a clearer picture. The findings will eventually benefit grain producers in the Western Cape with their fertilisation programmes.

Keywords:

Chickpea, Faba bean, Lupin, Pea

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Introduction:

To feed an ever-growing population on limited arable land, production systems should be optimised and adapted to address global warming challenges. Current agricultural management strategies still rely mainly on mineral fertilizer use, which has a long term negative impact on soil quality and microbial structure (Li et al., 2017 & Shen et al., 2019). Studies have shown that plant growth promoting rhizobacteria (PGPR) used in combination with mineral fertilizers can increase fertilizer use efficiency without negatively impacting plant health and yields (Baris et al., 2014). The aim of this study was to evaluate the infield effect of selected biofertilizers on wheat biomass and yield in an integrated phosphate management system.

Materials and Methods

The trial was planted at the Towoomba ADC (Limpopo Department of Agriculture Research Station, Limpopo Province, South Africa) using the RCBD experimental design. Soils were exposed to two PGPR treatments (T19 & T29) and a control at five phosphate (P) increments from the recommended P level of 50kg/P/Ha (0%, 25%, 50%, 75% & 100%). Nitrogen (N) levels were constant at 180kg/N/ha. The treatments were replicated three times and each consisted of 2 m × 2 m blocks with a 1.5 m buffer zone. Each treatment was prepared before planting by inoculating wheat seed (Duzi®) and irrigated bi-weekly to field capacity until maturity (12% grain moisture). Growth rate, biomass and yield data were collected by harvesting a 2 m² area within the block. The data was subjected to proc GLM procedures of SAS 9.4 (Statistical Analysis System, North Carolina, U.S.A) at P=0.05 and the means were separated using the Dunnett's test where significances were observed.

Results and Discussion

A direct relation between biomass and yield was observed but no significant increase in growth or biomass was noted between the treatments and respective controls. Treatment T19 significantly increased wheat yield at a 0%, 50% and 75% phosphate level by 0.49t/ha, 1.89t/ha and 1.54t/ha when compared to the respective controls. Treatment T29 significantly decreased yield only at a 0% P level but increased yield at all other P levels of between 0.35t/ha and 3.51t/ha compared to the controls. The results of the current study are supported by Batool & Altaf (2017) findings that showed PGPR effectiveness is most effective at a 75% P level but stability deteriorates at lower P levels.

Conclusion

The results indicate that phosphate levels influence the selected PGPR ability to increase wheat yield and must be considered when adopted in agricultural management systems.

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Keywords:

PGPR, yield, fertilizer

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3	Dr Ernest Dube	Nelson Mandela University
1	Mr. Theunis Jacobus Engelbrecht	Nelson Mandela University

Introduction:

Cover crops have the potential to offer improvements to soil structure, water relations and soil biological life. As fodder it offers a more balanced diet than a pure crop stand. The aim for this study was to evaluate different cover crop mixtures as potential pastures.

Materials and Methods

Eight mixtures were compared to 2 controls (oats and medics). During the production season 5 biomass cuts (2.2m x 1m) were made. Each plot was weighed to obtain wet biomass. A representative sample was taken and dried to determine dry matter yield. The data of the different cuts was subjected to analysis of variance (ANOVA). Fisher's least significant difference was calculated at the 5% level to compare treatment means and Dunnett's t test to compare mixtures to controls.

Results and Discussion

During the production season the growth of the different treatments varied significantly. Throughout the season positive growth was recorded except for three out of the forty readings that recorded negative growth. The reason for negative growth was herbicides that had to be sprayed on two of the treatments to gain control over Gousblom (*Arctotis hirsuta*) weed species. Growth and thus biomass production was slow in the beginning of the season (first two cuts after emergence) but increased noticeably from there to the end of the season. Fifty percent of the treatments peaked at four months after emergence. At the second cut, oats control produced the second highest biomass, with the 70% legume/30% cereal treatment, the highest. At the third cut all of the treatments out competed the oats control and seven treatments produced more biomass than the medic control, while after four months all eight mixture treatments outperformed the two controls.

Conclusion

The biomass production of cover crops is sufficient to sustain grazing by livestock, provided grazing is managed correctly. The different cover crop treatments did not vary considerably from the two controls but this changed from the third month after emergence. The different treatments produced better growth and biomass production in contrast to the two controls – especially during the fourth cut. The growth and biomass data will be combined with nutritional value of each treatment in order to find the most efficient treatment to serve as fodder for livestock.

Keywords:

Mixed cover crops, dryland, fodder/pasture, conservation agriculture, nutrient value, biomass, regrowth, quality

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1	Rotondwa Pascalia Gunununu	Department of Crop Sciences, Tshwane University of Technology

Introduction:

Common bean (*Phaseolus vulgaris* L.) is one of the most important legumes that serves as a source of protein in human diet. The crop can fix N₂ through symbiotic relationship with diverse rhizobia, thereby improving its productivity under minimal or no synthetic nitrogen fertilizer application

Materials and Methods

This study assessed the diversity and phylogenetic relationships among rhizobia responsible for common bean nodulation in Eswatini. For this, rhizobia were isolated from root nodules of different common bean genotypes grown in the field at the Malkerns Research Station in Eswatini.

Results and Discussion

ERIC-PCR fingerprinting of 87 authenticated rhizobial isolates from the different common bean genotypes revealed the presence of high genetic diversity. The dendrogram constructed from the ERIC-PCR profiles of the isolates grouped them in 11 major clusters; when considered at a 70% similarity cut-off point, the 87 isolates represented 83 ERIC-PCR types, a further indication of the diversity among the bean isolates. The sequence analysis of the 16S rRNA gene sequences of 14 representative isolates from the different ERIC-PCR clusters showed that the microsymbionts of common bean were closely aligned with the references strains of *R. freirei*, *R. tropici*, *R. paranaense*, *Candidatus Rhizobium massiliae* and *R. pusense* with the sequence similarities between 94% to 100%. Moreover, a phylogram constructed from the concatenated sequences of *glnII*+*dnaK*+*rpoB* genes were largely congruent with the 16S rRNA phylogeny and grouped the isolates into three clusters close to the type strains *R. muluonense*, *R. paranaense* and *R. pusense*. On the other hand, the phylogeny based on symbiotic genes (*nifH* and *nodC*) were incongruent with the phylogenies of the 16S rRNA and housekeeping genes, probably due to the acquisition of symbiotic genes through horizontal gene transfer

Conclusion

This study represents an important contribution to the literature about microsymbionts nodulating grain legumes in Africa, especially with the evidence provided here on the presence of high genetic diversity of common bean microsymbionts in Eswatini soils. Findings of this study are also evidence proving that common bean can form symbiotic relationship with different rhizobial species. Phylogenetic studies of rhizobial isolates from common bean planted in Eswatini revealed the presence of potentially novel groups of rhizobia in that environment that are still waiting to be properly identified

Keywords:

ERIC-PCR, House-keeping genes, symbiotic genes, microsymbionts

Presenter: Bagaisi Mirriam Islam (meriamsa32@gmail.com)

Author(s)

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1	Bagaisi Mirriam Islam	North West University
4	Prof Erick Sebetha	North West University

Introduction:

Drybean (*Phaseolus vulgaris* L.) is considered one of the most important grains for human consumption. The major problem that farmers in South Africa experience is decline in drybean yields as a result of inadequate supplies of the phosphorus fertilizer on account of the high cost of the product. The objective of this study was to determine the effect of phosphorus fertilizer rates, cultivar and location on drybean yield.

Materials and Methods

The study was carried out during 2017/18 planting season at three different locations in North West province, namely, Mafikeng, Taung and Ventersdorp. The experimental design was a $5 \times 3 \times 3$ factorial experiment fitted in a randomized complete block design (RCBD) with 4 replications. Three different cultivars of drybean (PAN 148, PAN 123 and PAN 9292) were planted and five rates of phosphorus fertilizer were applied, namely 0, 30, 45, 60 and 75 kg P/ha-1 at Taung; 0, 45, 60, 75 and 90 kg P/ha-1 at Ventersdorp and 0, 110, 114, 118 and 120 kg P/ha-1 at Mafikeng. Measured yield parameters were grain yield, number of pods per plant and seed mass.

Results and Discussion

Drybean cultivar and location had significant effects ($P < 0.005$) on pods per plant, 100- seed mass and grain yield. The higher number of pods of PAN 123 could be attributed to the genotypic characteristics of the cultivar. Significantly, drybean planted at Taung produced largest number of pods per plant. The higher number of pods per plant could be attributed to the higher rainfall received. The higher 100 seed mass in PAN 9292 could be attributed to the difference in seed size of cultivars. The higher 100 seed mass value at Mafikeng could be attributed to the greater nutrient availability in the soil and the better translocation of photosynthates from source to sink

Conclusion

Cultivar had a significant effect on the number of pods per plant, 100 seed mass and grain yield. Drybean cultivar PAN 9292 is considered as the good cultivar for production due to its higher seed mass and grain yield. In terms of location, Taung is recommended as the appropriate location for drybean production. The results showed that, on soil with high phosphorus content, phosphorus application does not have any effect on the yield.

References

Drybean Yield under the Influence of Cultivar, Phosphorus Fertilizer Rate and Location. Indian Journal of Agricultural Research. 54(4): 536-540.

Keywords:

Grain yield, seeds per pod, pod mass, seed mass, fertilizer rates.

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Introduction:

Extreme weather events are likely to increase in South Africa due to the effects of climate change. Interventions to improve water security are essential in rural areas that are not supplied with bulk water infrastructure. The objectives of this study were to assess the feasibility and sustainability of solar panel-powered pumps for abstraction of groundwater and water from sand river alluvium in support of emerging farmers and communities in drought-affected areas of Greater Giyani Municipality (Limpopo Province).

Materials and Methods

The feasibility assessment included geophysical, technical/engineering, socio-economic/financial and environmental aspects. The methodology followed the process recommended by GIZ and FAO (2021) in the “Toolbox on Solar Powered Irrigation Systems (SPIS)”, as the SPIS Toolbox was developed primarily for small-scale irrigation. Data on climate, geohydrology, soil, land use, farming practices, financials, market and institutional information were collected to populate the SPIS Toolbox. Extensive stakeholder engagements also served to gather input data and information. The analysis was done for a hypothetical, typical small-scale farm growing three intensively cultivated and irrigated vegetable crops per year on 0.5 ha of land.

Results and Discussion

Geophysical parameters indicated that the area is moderately suitable for solar-powered groundwater systems. The peak water requirement of the farm is 33.9 m³/d in the month of December. This volume of water corresponds to the water supply to a village of about 1,350 people at a rate of 25 L per person per day. The solar-powered system will take 4 years to payback with estimated cost savings of >R400,000 compared to a grid-powered system for a life cycle of 25 years. Using fuel to pump groundwater is not financially viable. Given the technical design configuration for the small-holder farm used as an example, the system requires between 1.4 and 1.5 kWp to power the pump with a solar panel surface between 9.3 and 10 m². Feasible financial mechanisms were identified to be leasing, cooperatives, informal saving groups and pay-per-use, however it is likely that subsidies will be required at least during the piloting phase.

Conclusion

The use of solar-powered groundwater pumping systems may result in beneficial impacts on water security, agricultural production and value-chain. However, water resource abstraction and management will have to be monitored to ensure sustainability.

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GIZ and FAO 2021. Toolbox on Solar Powered Irrigation Systems (SPIS). https://energypedia.info/wiki/Toolbox_on_SPIS.

Keywords:

Emerging farmers, Engineering design, Geophysical assessment, Photovoltaic cells, Socio-economic assessment, Stakeholder engagement

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8	Akhona Mbatyoti	3North-West University, Unit for Environmental Sciences and Management, Intergrated Pest Managent, Private Bag X6001, Potchefstroom 2520, South Africa.

Introduction:

Cowpeas *Vigna unguiculata* (L. Walp.) is an important legume crop indigenous to Africa. In African countries cowpeas have various uses that includes livestock feeds, human consumption and improvement of soil fertility. When cowpea is utilized in crop rotation systems, it provides build-up of organic matter as well as nitrogen and carbon fixation, which results in improved soil fertility and enhancing the physical characteristics of soils (Sánchez-Navarro, Zornoza, Faz & Fernandez., 2019a). Reports on the interactions of nematodes and nitrogen-fixing bacteria have been very inconsistent and contradictory, making nematode management decisions in legumes a challenge (Veken et al., 2020). *Rhizobium leguminosarum* will reduce the severity of *Meloidogyne enterolobii* on six farmer retained cowpea cultivars and improve the growth of six farmer retained cowpea cultivars.

Materials and Methods

The study was conducted at the University of Mpumalanga, under greenhouse conditions at 23-28° F. It was a 3x6 factorial design experiment (RCBD) with 5 replications. Six cowpea cultivars were planted in plastic pots containing pasteurized soil and were then inoculated with 5000 *M. enterolobii* J2 before, with, and after inoculation with *R. leguminosarum*. After 77 days of planting plant growth variables, nematode variables, and rhizobia variables were measured.

Results and Discussion

The relationship between the two microorganisms was observed to vary with cultivar. Time of bacterial inoculation in relation to the nematode did not differ but cultivars differed in their response to the nematode species. *Meloidogyne enterolobii* had differing effects on number of total bacterial nodules and number of active nodules formed on roots of different cultivars. Of the six cultivars “Cv17A” had significantly the highest number of nematode J2 and eggs in the roots while “Cv17D” had significantly the lowest number of J2 and eggs in roots. The treatment that had the highest number of nematode J2 and eggs in the roots was nematode inoculation first while the lowest was rhizobia inoculation first. The relationship between nematodes and nitrogen-fixing bacterial is more complex than previously reported, with this relationship probably varying with nematode species, plant species and cultivars within each plant species.

Conclusion

In the current study, nematodes had a direct effect on the cowpea nodulation and proportion of active versus inactive nodule numbers irrespective of nematode inoculation time relative to the time at which nitrogen-fixing bacteria inoculation was done.

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Keywords:

Bio-control, Root-knot nematodes, Plant-growth promoting rhizobacteria, leguminous plants, Nodulation, Gall formation

EFFICACY OF MAERUA ANGOLENSIS PLANT EXTRACT IN THE MANAGEMENT OF MELOIDOGYNE INCOGNITA IN BAMBARA GROUNDNUTS RETAINED VARIETIES

Poster

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Introduction:

Bambara groundnut (*Vigna subterranean*) is mainly grown by subsistence farmers with the potential of addressing malnutrition and food insecurity challenges (Mayes et al., 2019). A variety of factors, including plant pathogenic nematodes, have an impact on Bambara groundnut productivity. Chemical management is costly and only economically feasible for high-value crops, and it poses a risk to the environment and human health (Tsay et al., 2004). Due to these inconveniences, the use of indigenous plant extracts has gained importance in pest management in recent years (Khosa et al. 2020). Therefore, the hypothesis of the study was that *Maerua angolensis* plant extracts will reduce the population of *Meloidogyne incognita* on Bambara groundnut.

Materials and Methods

Bambara groundnut varieties were planted in thirty-centimeter diameter plastic pots and placed in greenhouse conditions with temperatures ranging from 25-30 degrees celcius. Bambara groundnut seedlings were inoculated with 5 000 *M. incognita* eggs and second-stage juveniles using a 20 ml plastic syringe by putting them on cardinal stem points in a 2½ cm deep hole. The experiment was a 6 x 5 factorial design laid out in a randomised complete block design with 10 replications. The first factor consisted of six varieties and the second factor was made up of three *M. angolensis* powders (0, 5, 10, 15 g/plant) and nemacur. Plant and nematode variables were collected and analysed.

Results and Discussion

There were significant interactions between plant extracts and varieties for all measured nematode and plant growth variables. Nematicur consistently reduced nematode densities in roots of all six varieties, whereas, the effectiveness of the three plant extract levels varied with variety. Plant extract did not control the total nematode per plant but increased all plant growth variables. The current results contradict work by Khosa et al. (2020) who reported *M. angolensis* suppressing nematode population densities significantly by 87 to 88% and suppression of *M. incognita* caused by *M. angolensis* was similar to the suppression caused by Nematicur in 2008 and 2009. Inconsistencies caused by *M. angolensis* have been observed in different years (Khosa et al., 2020). Coyne et al. (2005) reported improved plant growth variables associated with improved soil properties.

Conclusion

Effective control of *M. angolensis* on Bambara groundnut varies between varieties was tested. Suppressive effect of plant extracts was comparable to nematicur for var. 'DB-W'. The use of *M. angolensis* extract has potential as an efficient and cheap method of nematode control in Bambara groundnuts.

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Keywords:

Bambara groundnut, *Maerua angolensis*, nemacur

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Introduction:

Soybean is one of the most important crops in South Africa. There is speculation that N nitrogen (N) supplied through nitrogen - fixation is not necessarily adequate to maximise soybean grain yield (Gai et al., 2017). On the other hand, plant density affects soybean growth and grain yield. The aim of the study was to evaluate the effect of N application rate and plant density on grain yield of soybean (*Glycine max.*).

Materials and Methods

The study was conducted in Mthatha Dam Research Station in Mthatha in the 2020/2021 growing season as a 3X3 Factorial Experiment in a Randomized Complete Block Design replicated three times. The three levels plant density were: 100 000, 200 000 and 300 000 plants/ha, respectively. The three N levels were 0, 50 and 100 kg/ha. The plant density was allocated to the main plot and N levels as sub-plots. Seeds were inoculated with *Bradyrhizobium japonica*. The data for grain yield and related yield components was collected from all the plants in the net plot of 1m x 1m. The yield parameters were the number of pods per plant, number of seeds per pod, weight of 100 seeds, grain yield per plant, grain yield per square meter, total dry matter and harvest index. Analysis of variance was done using JMP 14th edition. Means were separated using the Fisher's protected least significant difference (LSD) test at $p = 0.05$.

Results and Discussion

Nitrogen rate significantly influenced plant height, number of seeds per pod and 100-seed weight. Similarly, plant density significantly affected the number of seeds per pod and 100-seed weight. Increasing plant density and N level increased these parameters. No significant plant density x N interactions were observed. However, 200 000 plants per ha and 100 kg N per ha resulted in improved plant height, 100-seed weight and grain yield.

Conclusion

Plant density and N levels affected plant height, seed per pod and 100-seed weight as main factors. The combination of 200 000 plants per ha and 100 kg N per ha increased plant height, 100-seed weight and grain yield. These results are preliminary and continuation of this study is recommended.

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Gai Z, Zhang J, Li C. 2017. Effects of starter nitrogen fertilizer on soybean root activity leaf photosynthesis and grain yield. Plos One. <https://doi.org/10.1371/journal.pone.0174841>

Keywords:

Bradyrhizobium japonica, N application rate, seeds pod-1

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Introduction:

For many South African households, calorie-rich foods are easily accessible but the challenge is accessing sufficient and affordable micronutrient-rich vegetables (Bouis et al. 2011). A study by Ritchie et al. (2017) showed that the lack of essential micronutrients like Vitamin A, iron (Fe) and zinc (Zn) in the diet may lead to morbidities like obesity, malnutrition, stunted growth and learning difficulties in children. Most poor households in urban areas lack farming land but may have backyard spaces where a variety of vegetables can be grown to increase micronutrient consumption and diversify their diet (Van Auerbeke 2007). The aim of this study was to test a few commercial vegetable crops in a vertical hydroponic system whereby the growth rate, yield and nutritional quality in terms of Zn, Fe and protein were determined.

Materials and Methods

A randomised factorial design consisting of 16 vertical farming structures were constructed to have an East and West facing side. Three vegetable types were grown in two types of growth media (compost and soil). To avoid soil compaction, vermiculite was mixed with soil at a rate of 1:4. Randomly selected experimental units were treated with micronutrient fertilizer at 1 ml/l whilst others received no treatment (0 ml/l). Green bean pods were harvested weekly where the number of pods, seeds per pod, length and mass of pods was measured. The sweet potato was harvested once where the number of tubers per plant, fresh and dry aboveground biomass was recorded. Crops were dried, crushed into powder and analysed to determine the nutrient content in the plant and soil. Statistical data was analysed using SAS® at a probability level of 5%.

Results and Discussion

The average number of green bean seeds per pod were significantly higher (LSD (5%) = 1.4591) for plants grown on the West (7.06) than on the East (4.88). A higher number of seeds per pod was obtained from plants treated with micronutrient fertilizer (6.75) as compared to untreated plants (5.18).

The yield of sweet potato tubers obtained in plants grown in compost was significantly higher (170) than plants grown in soil (141). There were no significant impacts on sweet potato yields as influenced by micronutrient fertilizer application.

Conclusion

The observed high yields from plants grown in compost show its great potential to be a recommended growth media for vertical farming. Combining crops harvested once with those harvested continuously can be a good consideration to contributing to the nutritional needs of a household.

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Keywords:

Compost, micronutrients, soil, vertical structures

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Introduction:

Consumer demand for quality melons with high nutritional value and flavour is increasing; however, melons are highly susceptible to diseases, which affect yield productivity and fruit quality parameters. Grafting may provide a solution to these problems, but conflicting reports exist on whether grafting is beneficial or detrimental to fruit quality (Fallik et al., 2019; Zhao et al., 2011; Roupheal et al., 2010). The study assessed the effects of two interspecific hybrid squash rootstocks (*Cucurbita. maxima* × *Cucurbita. moschata*), grafted with cantaloupe cultivars on the composition and sensory attributes of melon fruits, total soluble solids (TSS), titratable acidity (TA), total phenolic content (TPC), and antioxidant activity (FRAP) of melon at harvest.

Materials and Methods

Seedlings of cantaloupe Melon (cvrs. Hunter and Majestic) (*Cucumis melo*.L.var. *Cantalupensis*) grafted on Carnivor and Kickstart rootstocks and ungrafted (control), were transplanted in soil in a 20 m² plastic tunnel at Hygrotech Experimental Farm, Dewagendrift, Pretoria. Treatments were arranged in a randomized complete block design with four replicates. Fruits were harvested manually when they reached commercial maturity. At harvest, the TSS, TA, TPC, and FRAP were determined according to standard procedures. HPLC-PDA was used to quantify carotenoids (β -carotene & lutein) and consumer acceptance test was performed. The generated data were analysed using GenStat and significant treatment means were separated using Fischer's LSD test.

Results and Discussion

Total Soluble Solids increased by 12.6% in Carnivor grafted with Majestic (M/C), 4% in Kickstart grafted with Majestic (M/K), 11% in Carnivor grafted with Hunter (H/C), and 3.7% in Kickstart grafted with Hunter (H/K) following grafting. In general, the 'Carnivor' rootstock produced higher TSS values than the 'Kickstart' rootstock. Even though both rootstocks improved the TA, the highest TA was found in M/C (0.28) and H/C (0.28). Antioxidant activity were significantly higher in grafted than ungrafted fruits, and the highest FRAP was obtained in H/C. TPC was high in 'M/C' (30.15 mg GAE/100g) and 'H/C' (30.28 mg GAE/100g). Rootstock usage resulted in improved carotenoid profiles (β -carotene and lutein). Panellists preferred grafted cultivars due to their colour, flavour, juiciness, firmness, and overall eating quality. Ungrafted cantaloupe melons, Majestic and Hunter were the least liked.

Conclusion

Although both rootstocks displayed a good affinity with the scion, Carnivor rootstock significantly improved fruit quality. Therefore, selection of the right rootstock and cultivar combination is crucial in improving fruit quality.

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Keywords:

Grafting, marketable yield, fruit quality, soluble solids, sensory evaluation

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Introduction:

Farmers reported a decline in yield and longevity of rooibos over the years. The commercial solution was to apply chicken manure as biological nitrogen source, even though no confirmation from soil or foliar analyses to support this practice was available. Our hypothesis is that the use of commercial chicken manure negatively influences the free-living soil microbes as well as the formation of symbiotic associations such as mycorrhizae and Rhizobium, which in turn will affect the production and the lifespan of the plants, all influencing the quality of the tea. Increased phosphorous levels in the soil resulting from the application of chicken manure may contribute towards the decline in longevity. The effect of commercial chicken manure, as well as commercially available mycorrhizae, on soil microbes, root inoculation and the establishment and early development of rooibos plants was studied. Since the polyphenol content of the plants influences the taste of the tea, this was also measured in the final harvest.

Materials and Methods

An outdoor pot trial with six replications was established at Elsenburg, Western Cape Province. Soil and seedlings were obtained from rooibos farmers. Four treatments were applied: control – no additives; commercial chicken manure; mycorrhiza and a combination of chicken manure and mycorrhiza. Plants were sampled destructively every two months to quantify biomass. At the same time, active carbon, microbial activity, substrate utilisation and protozoa were monitored in the soil. Nitrogen binding bacteria was estimated molecularly. The polyphenol content was established in the plants at the final harvest date.

Results and Discussion

The addition of chicken manure had a significant influence on the polyphenol content of the green rooibos – possibly affecting the taste of the final product. The soil microbial activity was also significantly influenced by the different treatments.

Conclusion

The addition of chicken manure may influence the taste and thus quality of the final product. This trial should be conducted in the field on a longer term basis to study the effects at least up until first harvest.

Keywords:

Aspalathus linearis, longevity, phosphorous, soil biology, yield

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Introduction:

Sorghum (*Sorghum bicolor* L.[Moench]) ranks second after maize (*Zea mays* L.) for preference and importance, and it remains a critical food security crop for the livelihoods of more than 100 million people in sub-Saharan Africa. Understanding the distribution of the collected and conserved sorghum and maize landraces in the germplasm collections across South Africa is crucial in the conservation of plant genetic resources for food and agriculture. The aim of the study was to map the geographic distribution and quantifying the distribution of sorghum and maize landraces in germplasm collections in South African genebank from 1996 to 2008.

Materials and Methods

A total of 312 and 888 collection data, respectively for sorghum and maize accessions, collected between 1996 and 2008 was extracted from the genebank database of the conserved landraces in South Africa. A spatial distribution of the Sorghum accessions was based on the geographical position of 152 villages located in 57 local municipalities, situated in 23 District Municipalities in six (6) Provinces, whereas Maize accessions were from 242 villages located in 56 local municipalities, situated in 22 District municipalities in six (6) Provinces. The DIVA-GIS software was used to map the geographic distribution of both Sorghum and Maize accessions in germplasm collections. SPSS 20 was used to quantify the distribution of both sorghum and maize accessions collected.

Results and Discussion

The results revealed that the distribution of sorghum collection ranged from 3.5% accessions to 40.1% accessions, with the minimum collections recorded in the Free State Province and the maximum collections from Limpopo Province. The collection of maize accessions, however, ranged from 1.4% in the North West Province, to 33.8% in the Eastern Cape Province for a period of 12 years. The collection of sorghum in 2003 increased by more than three (3) time the initial collection in 1996. Contrarily, there was a decreasing trend of more than 89% of the collected sorghum accessions between 2003 and 2008. Similar trend was observed on maize accessions collected, with maximum collection observed in 2002 (30.9%) and 2003 (30.6%) as compared with the initial collection in 1996 (1.5%). The downward trend of the collection of maize accessions was observed between 2003 to 2008.

Conclusion

Between 1996 and 2008 collections, changes were observed in the geographical distribution on both sorghum and maize germplasms in South Africa, which could be explained by modifications in climatic and agronomic conditions, or by the emergence of new varieties and/or the development of new agricultural practices.

Keywords:

landrace, germplasm, accession

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Introduction:

Agriculture is a major contributor of greenhouse gas (GHG) emissions. GHGs associated with agricultural systems are carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). CO₂ is cycled extensively through agricultural systems and stored in the soil fraction as soil organic carbon (SOC), potentially offsetting CO₂ emissions. Cereals like wheat (*Triticum aestivum*), are high biomass producers with a high C:N ratio, which is resistant to microbial breakdown. Legumes such as lupins (*Lupinus* spp.), and pasture legumes (*Medicago* spp.), have a lower C:N ratio, and are broken down quicker into plant available nutrients. Climate greatly affects SOM (soil organic matter) sequestration and stabilisation, followed by soil, tillage treatment, and only thereafter by crop. Different crop rotations systems were investigated for differences in SOC.

Materials and Methods

The experimental site was a long-term crop rotation trial that was established in 1996, situated at Langgewens Research Farm, Moorreesburg. This trial features eight 4-year crop rotation systems consisting of combinations of wheat (W), lupins (L), Canola (C), Medic pasture (M), Medic/Clover mixed pasture (Mc), and the addition of livestock grazing on saltbush to allow the medic pasture to establish (+S). The treatments were WWWW; WWWC; WLWC; WWLC; WMWM; WMcWMc; WMCM; WMcWMc+S. Annual soil lab tests using the Walkley-Black method were done to determine soil organic carbon (SOC). For sampling, composite samples of 20 subsamples were taken at a soil depth of 150 mm throughout each camp. The average camp SOC values were then analysed using mixed models in STATISTICA.

Results and Discussion

Over time all rotation systems increased SOC. Rotation systems with cash crops only had slightly higher increases in SOC when compared to rotation systems featuring a pasture, but the differences are not significant. The systems with the highest potential to sequester carbon was WWLC, but it only differed significantly ($p < 0.05$) from systems WWWW and WMcWMc. Many other factors could influence these results such as the soil heterogeneity across fields, altitude, and aspect.

Conclusion

No system stood alone as significantly better than all the others and soil carbon increases and vary year to year. Cash-crop systems (with the exception of the monoculture) have a higher potential to build up SOC when compared to systems including a pasture phase. This is likely due to the high root biomass production of cereals that are recalcitrant to breakdown.

Keywords:

Carbon sequestration; crop rotation; greenhouse gases; conservation agriculture

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Introduction:

The optimum planting period for maize (*Zea mays* L.) in KwaZulu-Natal is from mid-October to mid-November. The recommended seeding rate is from 40 000 to 60 000 seeds/ha depending on locality and cultivar (Mallet, 1993). In light of reported climatic changes, a study was conducted to investigate the interactive effect of planting date, cultivar maturity group and seeding rate on grain yield under rain-fed conditions at the Cedara Research Station, KwaZulu-Natal.

Materials and Methods

Field trials were conducted in the 2017/18 and 2018/19 growing-seasons using a split-plot design and three replicates. Six planting dates (26SEP, 17OCT, 07NOV, 28NOV, 19DEC and 09JAN) were arranged as the whole plots, with three cultivars (PHB 33H54BR (Short-season), DKC 73-74BR (Medium-season) and PAN 6R-680R (Long-season)), as the sub-plots, and two seeding rates (44 444 and 66 666 seeds/ha) randomised within the whole-plots.

Results and Discussion

A significantly higher mean yield was measured in the 2017/18 (9.25 t/ha) compared to the 2018/19 growing-season (8.35 t/ha), due to higher rainfall. The yields produced in the 2017/18 growing-season were significantly higher from 26SEP to 7NOV compared to the later planting dates, while in the 2018/19 growing-season the yields were significantly higher at 17OCT and 7NOV. The short-season cultivar produced significantly higher yields at 17OCT and 7NOV in the 2017/18 and from 17OCT to 28NOV in the 2018/19 growing-season. The medium-season cultivar produced significantly higher yields from 26SEP to 7NOV and at 17OCT and 7NOV in the 2017/18 and 2018/19 growing-seasons, respectively. The long-season cultivar produced significantly higher yields at 17OCT in the 2017/18 growing-season and from 26SEP to 7NOV in the 2018/19 growing-season. The short and medium-season cultivars produced significantly higher yields at 66 666 seeds/ha (8.27 and 10.19 t/ha, respectively) compared to 44 444 seeds/ha (7.17 and 8.52 t/ha, respectively). Seeding rate had no significant effect on the yield of the long-season cultivar. Overall, the short-season cultivar produced a significantly lower mean yield (7.72 t/ha) compared to the medium- and long-season cultivars (9.35 and 9.32 t/ha, respectively).

Conclusion

The results indicate that the optimum planting period for the three maturity groups concurs with the standard recommendation (from mid-October to mid-November). To optimise production, the higher seeding rate should be used for the short and medium season, while the lower seeding rate was sufficient for the long-season cultivar. This recommendation is based on two seasons only and the research should be conducted for an extended period to be reliable for varying climatic conditions.

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Keywords:

maturity, sowing time, plant population

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Introduction:

Drybean (*Phaseolus vulgaris* L.) is nutrient-dense and rich in proteins and minerals (Cichy et al., 2019). High temperatures during the postharvest period of drybean can compromise the quality of the seeds (Scariot et al., 2017). The grains of drybean contain around 22-24% protein, mineral matter and vitamin-rich content as a significant agricultural commodity for human nutrition (Sozen, 2012). Therefore, the objective of this study was to see how phosphorus fertilizer source, cultivar, and location affected the quality of drybean grain.

Materials and Methods

This study was carried out at Mafikeng, Kraaipan and Taung in North-West, South Africa, in the 2019/20 growing season. The trial was a 3×4×2 factorial experiments fitted into a RCBD, with four replications. The four phosphorus fertilizer sources used were the control, single superphosphate, mono-ammonium phosphate and maxi phos. Fertilizer applications were based on the recommendations for drybean production after soil-sampling analyses had been conducted. Amounts of SSP, MAP and maxi phos were used at the rate of 180 kg/ha at Mafikeng, 60kg/ha at Kraaipan and Taung. The two cultivars planted were PAN 9292 and PAN 148. The cultivars were chosen on the basis of their maturity level. PAN 9292 matures in 85-110 days. PAN 148, on the other hand, matures in 90-95 days. The quality parameters were ash, crude fiber, fat, protein, and starch content. NIR Grain analyzer was used to determine the quality of grains.

Results and Discussion

Phosphorus fertilizer sources had no significant effect ($P \geq 0.05$) on ash, crude fibre, fat, protein and starch content of drybean. Though there was no significant differences in phosphorus fertilizer sources could be found, SSP-treated drybean produced a higher ash and crude fibre content. Location had a significant effect ($P \leq 0.05$) on ash, fat, protein, and starch content. These qualities might be attributed to the rainfall, temperature, the quality of the soil and the availability of soil nutrients. Cultivar had a significant effect ($P \leq 0.05$) on protein and starch content of drybean. These qualities might be attributed to genetic origin and seed traits of the cultivar.

Conclusion

In this study, phosphorus fertilizer sources were found to influence the quality of drybean grains. SSP and maxi phos are recommended as acceptable phosphorus fertilizer sources for good nutritional quality in the drybean grain. The results showed that early maturing cultivar performed better than late maturing cultivar. Therefore, drybean cultivar PAN 148 is recommended for success in the production of drybean and in good yields.

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Keywords:

Drybean, cultivar, location, phosphorus fertilizer source, quality

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Introduction:

Invasive alien weeds are a major threat to indigenous biodiversity and contribute to the limitation of crop production (Namkeleja et al., 2014). Mexican prickly poppy (*Argemone ochroleuca*) is an invasive alien weed found in almost all disturbed soils and has allelochemicals that have been reported to potentially inhibit crop growth (Muche et al., 2018). These weeds are highly adaptive and their ability to produce and release allelochemicals gives them a competitive edge over indigenous species. The effects of these weeds on germination have not been sufficiently documented (Pratt et al., 2017). The objective of this study was to empirically document the effects of *A. ochroleuca* extracts on germination of white kidney beans.

Materials and Methods

Germination tests were conducted following the procedures of the International Seed Testing Association (Jones, 2013). Roots and shoots (100g) were weighed separately and mixed with 1000ml of distilled water for 24 hours. Ten white kidney bean seeds were exposed to eleven Mexican prickly poppy shoot and root extract concentrations of 0, 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 g/L of distilled water. The experiment was carried out in 9-cm-diameter Petri dishes lined with filter paper under laboratory conditions at approximately 25°C. Treatments were arranged in a 2 x 11 factorial experiment with three replications. Data on germination percentages (GP), mean germination time (MGT), germination speed (GS), mean daily germination (MDG), plumule and radicle length were collected over a 7-day period.

Results and Discussion

The inhibitory response of Mexican prickly poppy was significant and concentration dependent. Lower extract concentrations from the leaves and roots of the weed stimulated plumule and radicle length, whereas higher concentrations inhibited the two variables. The relationships between the increasing leaves and root extract concentrations and germination variables, GP, MGT, GS and MDG, were explained by inhibition response only. As concentrations increased, germination variables decreased, with concentrations of 50 % and above decreasing GP, MGT and MDG, whereas, concentrations of 70 % and above reduced GS. The co-efficient of determination was high for all graphs ranging between 54 and 85%. The observed responses of *A. ochroleuca* extracts were also reported on the germination and growth of *Peganum harmala* and *Lactuca sativa* (Ahmed et al., 2020). Muche et al., (2018) reported that, germination and growth decreased with increasing extract concentrations.

Conclusion

Mexican prickly poppy extracts had concentration-dependent inhibitory effects on germination variables of white kidney bean. Shoot extracts exhibited higher allelopathic effects compared to root extracts.

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Keywords:

Allelopathy; *Argemone ochroleuca*; Invasive alien weeds; White kidney bean; Plant extracts

EFFICACY OF MAERUA ANGOLENSIS PLANT EXTRACT IN THE MANAGEMENT OF MELOIDOGYNE INCOGNITA IN BAMBARA GROUNDNUTS RETAINED VARIETIES

Poster

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Introduction:

Bambara groundnut (*Vigna subterranean*) is mainly grown by subsistence farmers with the potential of addressing malnutrition and food insecurity challenges (Mayes et al., 2019). A variety of factors, including plant pathogenic nematodes, have an impact on Bambara groundnut productivity. Chemical management is costly and only economically feasible for high-value crops, and it poses a risk to the environment and human health (Tsay et al., 2004). Due to these inconveniences, the use of indigenous plant extracts has gained importance in pest management in recent years (Khosa et al. 2020). Therefore, the hypothesis of the study was that *Maerua angolensis* plant extracts will reduce the population of *Meloidogyne incognita* on Bambara groundnut.

Materials and Methods

Bambara groundnut varieties were planted in thirty-centimeter diameter plastic pots and placed in greenhouse conditions with temperatures ranging from 25-30 degrees celcius. Bambara groundnut seedlings were inoculated with 5 000 *M. incognita* eggs and second-stage juveniles using a 20 ml plastic syringe by putting them on cardinal stem points in a 2½ cm deep hole. The experiment was a 6 x 5 factorial design laid out in a randomised complete block design with 10 replications. The first factor consisted of six varieties and the second factor was made up of three *M. angolensis* powders (0, 5, 10, 15 g/plant) and nemacur. Plant and nematode variables were collected and analysed.

Results and Discussion

There were significant interactions between plant extracts and varieties for all measured nematode and plant growth variables. Nematicur consistently reduced nematode densities in roots of all six varieties, whereas, the effectiveness of the three plant extract levels varied with variety. Plant extract did not control the total nematode per plant but increased all plant growth variables. The current results contradict work by Khosa et al. (2020) who reported *M. angolensis* suppressing nematode population densities significantly by 87 to 88% and suppression of *M. incognita* caused by *M. angolensis* was similar to the suppression caused by Nematicur in 2008 and 2009. Inconsistencies caused by *M. angolensis* have been observed in different years (Khosa et al., 2020). Coyne et al. (2005) reported improved plant growth variables associated with improved soil properties.

Conclusion

Effective control of *M. angolensis* on Bambara groundnut varies between varieties was tested. Suppressive effect of plant extracts was comparable to nematicur for var. 'DB-W'. The use of *M. angolensis* extract has potential as an efficient and cheap method of nematode control in Bambara groundnuts.

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Keywords:

Bambara groundnut, *Maerua angolensis*, nemacur

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Introduction:

Sorghum grain quality can be affected by cultivar choice and environmental conditions (Ebadi et al. 2005). Nitrogen fertilizer sources play a significant role on the quality of sorghum as it has influenced protein content (Ahmed et al., 2007). We hypothesize that there will be no significant difference amongst nitrogen source on sorghum grain quality. The aim of the study was to determine the quality of sorghum grains as influenced by nitrogen fertilizer source, cultivar, dryland and irrigation field.

Materials and Methods

The study was conducted for two seasons at the North-West University research farm, Molelwane. The experiment was a 2x5x2 factorial arranged in a split-split plot fitted into a randomized complete block design. Irrigation and dryland field conditions were the main plots, subplots reflected the nitrogen sources (LAN, urea, ammonium sulphate, ammonium sulphate nitrate, and control) and the sub-subplots reflected the cultivars (Titan and Avenger). Based on the soil analysis results, each nitrogen source dosage to be applied per plot was calculated based on the recommended rate of 120 kg N/ha and phosphorus dosage was also calculated based on the rate of 60 kg P/ha. Potassium was not applied in both seasons based on the analysis report. The irrigation field was supplied with water twice in one week in the absence of rainfall. The volume of water used for supplementary purposes was 17mm per day, depending on the strength of the wind and the availability of water. Sorghum grain samples harvested from an area of 9.92 m² within each plot were analysed for ash, fibre, fat, protein and starch contents.

Results and Discussion

Nitrogen fertilizer source had significant effect on protein during 2018/19 planting season. Sorghum treated with LAN had a higher protein compared to sorghum treated with other sources. This could be attributed to the easy translocation of LAN from the senescing leaves of plants during the grain-filling stage. Cultivar had significant effect on protein during the 2019/20 planting season. Cultivar Avenger had a higher protein compared to cultivar Titan's effect. This could be attributed to the short growth cycle of the cultivar, which facilitates the faster accumulation of protein during protein synthesis. Dryland field increased ash and fibre, and it may be attributed to the rapid production of grain yield. Whereas protein was increased under irrigation condition.

Conclusion

The study suggests that LAN can be considered for the quality of sorghum as it influenced protein content. Nutritional quality can be achieved under dryland field.

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Keywords:

Dryland, Irrigation, LAN, Nutrition, Protein, Urea

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Introduction:

Ecological adaptive traits of rhizobial isolates is a major challenge. Host range and cross infectivity studies are important for identifying rhizobial strains with potential for use as inoculants (Gyogluu et al., 2018). The aim of this study is to determine ecological adaptive traits of selected rhizobial symbionts. Nodulated legumes offer a great opportunity for improving the N of soils through their ability to establish effective symbiosis with root nodule bacteria genera *Rhizobium* and *Bradyrhizobium* (Nyemba and Dakora, 2010). The rhizobial symbionts exhibit similar adaptive traits and induce similar plant growth.

Materials and Methods

The study assessed C accumulation and $\delta^{13}\text{C}$ using $^{13}\text{C}/^{12}\text{C}$ natural abundance procedure for cross-nodulated diverse legume species by native rhizobial isolates in the glasshouse 2021 cropping season. The tested legumes are four which is bambara groundnut, cowpea, wing bean and chickpea. Determination of the shoot $^{13}\text{C}/^{12}\text{C}$ isotopic ratios was carried out at the Stable Isotope Laboratory, South Africa. Approximately 2.0 mg of finely ground plant material was weighed into aluminium (Al) tin capsules to determine %C and ^{13}C values using a Carlo Erba NA1500 elemental analyzer coupled to a Finan MAT252 mass spectrometer (Unkovich et al., 2008).

Results and Discussion

The result revealed high shoot dry matter on isolate DA-PUA 3(5) and DA-PUA 3(1) induced on bambara groundnut followed by isolate DA-PUA B2(2) induced on chickpea. C content revealed high values in DA-PUA 3(5) and DA-PUA 3(1) induced on bambara groundnut. The reported increase in shoot dry matter was likely due to greater C content. Isolate DA-TACHITIPIE 3 and DA-PUA 2 induced on wing bean caused an increase in C concentration relative to other tested legumes and isolates. $\delta^{13}\text{C}$ values ranged from isolate TUTAMY 110 (-23.47 ‰) induced on bambara groundnut to isolate TUTAMD 102 (-28.56 ‰) induced on chickpea. C:N ratios of legumes are measure of the relationship between N and C nutrition, which revealed high ratio of isolate TUTAMD 306 (48.05 g.g⁻¹) inoculated on cowpea to lower ratio of isolate DA-TACHITIPIE 3 (-25.77 g.g⁻¹) inoculated on wing bean. Bambara groundnut showed high values in shoot dry matter, C content and $\delta^{13}\text{C}$ followed by cowpea, chickpea and wing bean.

Conclusion

The findings showed significant differences between and among all tested legume species and treatments (isolates). This study showed that isolate TUTAMY 110, DA-PUA 3(5) and DA-PUA 3(1) induced on bambara groundnut has the potential for use as inoculants and productive plant growth.

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Keywords:

Treatments, Inoculants, Nodules, Water-use efficiency, Mass spectrometer, C content

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Introduction:

Conservation agriculture (CA) has shown to be of great benefit for the sustainable production of the winter cereal and canola systems of the southern Cape. However, certain regenerative agriculture (RA) practices may further promote the sustainable intensification of these production systems through added diversity and improved soil health. The aim is to evaluate the impact of biochar soil amendment on the activity of selected soil enzymatic activity assays under grazed cover crops.

Materials and Methods

The Tygerhoek RA trial is currently in its second production year. Preliminary information will be presented from a bigger study that runs over three years on cover crops subject to high density strip grazing by a herd of sheep during the winter growing season. The experiment was laid out in a split plot design with two treatment factors (biochar and season). Biochar was applied at 1 ton ha⁻¹ to half of all the cover crop plots in two separate applications, 7 June 2019 and 30 October 2020 (total of 2 t ha⁻¹). The half of each plot which received no biochar served as the control. Soil data from March 2020 (baseline) and March 2021 was compared. The impact of biochar on four enzymatic reactions was compared and evaluated. Analysis was done through a mixed model ANOVA in R (lmer package) and Fisher's least significant difference (LSD) was calculated at the 5% level to compare treatment means.

Results and Discussion

Biochar did not have an influence ($p \geq 0.05$) on the activity of acid-phosphatase, alkaline-phosphatase and urease activity. However it did have an effect ($p \leq 0.05$) on the activity of β -glucosidase. The β -glucosidase activity with no biochar was 1848 $\mu\text{g g}^{-1} \text{ h}^{-1}$ (± 413.6) and with biochar was 2158 $\mu\text{g g}^{-1} \text{ h}^{-1}$ (± 333.3). β -glucosidase plays a central role in soil organic matter (SOM) cycling, and its activity gives an early indication of changes in SOM status. Thus, increased β -glucosidase activity may be indicative of improved soil quality under biochar. This is preliminary data and will be repeated in a second season, which might give a clearer picture. Changing soil health is a process of time.

Conclusion

From the preliminary data it appears that the application of biochar shows promise for increasing the activity of β -glucosidase, and therefore improving soil quality.

References

Keywords:

β -glucosidase activity, forage crops, regenerative agriculture, soil health

EFFECTS OF PLANT GROWTH-PROMOTING RHIZOBACTERIA ON BAMBARA GROUNDNUT GERMINATION SUBJECTED TO DIFFERENT TEMPERATURE REGIMES

Poster

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Introduction:

Bambara groundnut is one of the most important underutilized indigenous African crops, primarily grown for human and livestock consumption. The percentage of Bambara groundnut yield being harvested has decreased substantially due to rising temperatures caused by climate change. Integrating environmentally friendly agricultural practices can improve crop productivity and advance the sustainability of agricultural cropping systems. Plant growth-promoting rhizobacteria (PGPR) have been shown to reduce the effects of heat stress on crops and increase yields.

Materials and Methods

A germination test was conducted using three Bambara groundnut landraces (red, cream, and brown) inoculated with *Bacillus subtilis* (strain BD233) incubated under three different temperatures (24°C, 27°C, and 35°C) for 14 days. Whatman No.1 filter paper disc and 9 cm petri dishes were used throughout the experiment. The moisture content of the filter paper discs was kept moist throughout the experiment. The number of germinated seeds was recorded at 2-day intervals for a period of 14 days and thereafter, the plumule length was measured using a vernier caliper (Model DC-515A). Germination percentage (G%), germination index (GI) and germination rate index (GRI) were calculated from germination data according to Olisa et al. (2010)

Results and Discussion

In general, the BD233 strain and high temperature promoted germination and longer plumule length among Bambara landraces. When brown Bambara groundnut landrace was inoculated with *Bacillus subtilis* (BD233 strain), germination percentage (95.83%), germination index (7.90), and plumule length (5.42 cm) were increased. The lowest germination percentage and the lowest plumule length were observed when Bambara groundnut landraces were not inoculated with strain BD233 at different temperatures.

In this study, inoculation with *Bacillus subtilis* (strain BD223) significantly enhanced the plumule length of two of the three Bambara landraces subjected to different temperature regimes. These findings could be attributed to the ability of *Bacillus subtilis* to increase the synthesis of plant growth regulators such as auxins, gibberellins, and cytokinins (Bottini et al., 2004; Bloemberg & Lugtenberg, 2001).

Conclusion

This study revealed that germination percentage and plumule length were highly influenced by temperature, landrace and inoculation with *Bacillus subtilis* (strain BD233). The strain BD233 can withstand the effects of high temperatures and boost agricultural productivity in future climate change scenarios.

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Keywords:

Bacillus subtilis, plumule length, germination percentage, germination index and germination rate index

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Introduction:

The accumulation of secondary metabolites varies greatly among different plants and among plant parts of the same plant, this may be due to the environment. In *Argemone ochroleuca* (Mexican prickly poppy), different amounts of the same compounds can be found in the shoots and roots, which is dependent on the habitat such as rangeland and farmlands (Dar et al. 2017). *Argemone ochroleuca* allelochemical properties have been reported, but not empirically tested on economically important staple cereal crops. Therefore, the aim of this study was to determine whether different plant parts of *A. ochroleuca* have suppressive effects on the germination of maize and pearl millet.

Materials and Methods

The suppressive effects of *Argemone ochroleuca* were tested using the shoot and roots extracts at 11 concentrations (0, 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100g/L water). The extracts were prepared by oven drying the roots and shoots at 55 °C for 72 hours. 100 g sample of each plant part was mixed with 1000 ml of distilled water for 24 hours and filtered. Germination tests were conducted following the guidelines proposed by the International Seed Testing Association (Jones 2013) and arranged in a Complete Randomized Design. Germination percentage, Germination speed, Mean germination time, Mean daily germination, plumule and radicle length were measured. The collected data was analyzed using Statistix 10.

Results and Discussion

The Allelopathic effects of *Argemone ochroleuca* were concentration and plant-part-dependent in response of pearl millet and maize germination, with higher concentrations having higher suppressive effects than lower concentrations. *A. ochroleuca* shoot extracts were more suppressive than root extracts on germination. In relation to the control, shoot and root extracts reduced germination speed of pearl millet by 25–86% and 33–82%, respectively. In relation to the control, shoot and root extracts reduced plumule length by 33–100% and 42–95%, respectively. Dar et al. (2017) observed higher inhibitory effects of shoot extracts of *A. ochroleuca* on germination of fodder plants than root extracts, moreover the inhibition of the plant parts was dependent on the habitat and reported that shoot extracts of *A. ochroleuca* in rangelands and farmlands decreased germination of all tested species compared to root extracts.

Conclusion

Argemone ochroleuca allelopathic effects were concentration and plant-part dependent, inhibitory effects increased with concentrations, with shoot extracts being more suppressive than root extracts. As *A. ochroleuca* continues to spread yearly without any control strategies in place, it will pose a threat on maize and Pearl millet production.

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Keywords:

Aqueous, Extracts , Plumule, Radicle, Roots, Shoots.

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Introduction:

Subsoil acidity has been proven to affect a large portion of agricultural soil in the Western Cape. With the adoption of no-tillage practices amongst numerous farmers in the Western Cape, pH stratification, subsoil acidity and aluminium toxicity manifestation concerns the sustainability of crop production. Although no-tillage is effective in sustaining crop production through soil health rehabilitation, the limitations regarding soil pH must be addressed. The aim of this study is attenuating pH stratification, subsoil acidity and aluminium toxicity in no-tillage farming systems.

Materials and Methods

Two field trials were established following a randomised block design to study lime movement and acid neutralisation. Trial sites were stipulated to have been under no-tillage practices for at least 8 years with cases of pH stratification and subsoil acidity. Site 1 is in the Southern Cape and was established in 2020. Site 2 is in the Swartland and was established in 2021. Treatments include a variety of lime forms and placement techniques including post application tillage actions. Treatments were replicated four times. Appropriate agronomic yield components of what and barley crops were sampled at relevant crop growth stages to evaluate crop performance. Soil samples at specific depth increments were analysed to study the effect of treatments on soil components.

Results and Discussion

Site 1 soil data for cropping season 2020 showed differences ($p < 0.05$) between treatments in the following soil-based components: pH, acidity, calcium content, cation exchange capacity (CEC), soil organic carbon (SOC) and sulphur content. Broadcast of pelletised lime showed the highest increase in pH within the 5 cm depth from an initial pH(KCl) of 5.5 to 6.3 after one cropping season ($p < 0.05$). Acidity neutralisation within the 15cm depth increment was only significant in the rip and disc tillage treatments during the first cropping season ($p < 0.05$). Site 1 crop data for cropping season 2020 showed no significant crop-performance differences ($p > 0.05$) between treatments except for grain moisture content ($p < 0.05$). Disc and rip tillage treatments resulted in highest grain moisture content of 16% and 15.6% respectively in comparison with control treatment of 14.7%. Soil and crop data for site 2 is not yet sufficient for notable statistical analyses, results, discussions, or conclusions.

Conclusion

Thus far only preliminary data is available. Provisional data indicates that strategic tillage can be considered when subsoil acidity severely affects crop production. Due to lime's low reactivity and mobility within soil more time is required for reliable recommendations.

References

Keywords:

aluminium toxicity, conservation agriculture, no-tillage, pH stratification.

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Introduction:

Soil and crop health status determine the profitability and sustainability of agriculture. Vital organic matter and nutrients are often destroyed, depleted, or otherwise lost from the soil through over-use of chemical fertilizers, erosion, and runoff as a consequence of unstable farming practices. Microbe-rich soil reduces the need for chemical fertilizers. The objective of this study was to assess the effect of an organic crop enhancer (Bontera) in combination with chemical fertilizer on the germination, growth and yield of beetroot over two seasons.

Materials and Methods

The research was conducted at the University of Pretoria experimental farm for pot trials and Organico experimental farm in Centurion, South Africa for field trials. Trials were conducted during the 2018 winter and 2018/2019 summer growing seasons. Winter trials consisted of field and pot trials while summer trials consisted of only field trials. Standard germination tests for beetroot seeds were done using a control (only water) and three concentrations of Bontera (1:500, 1:1000 and 1:1500). Treatments for field and pot trials consisted out of a control receiving no Bontera or fertilizer, Bontera alone, full complement of recommended fertilizer (100% fertilizer), 75% of recommended fertilizer, Bontera plus 100% fertilizer and Bontera plus 75% fertilizer. For both pot and field trials, a randomized complete block design with five replicates was used and the data were analyzed using Statistix version 10.

Results and Discussion

Seeds treated with a microbial crop enhancer promoted early germination. Treatments with Bontera plus 75% fertilizer showed an increase in most yield parameters, however, in these cases it seldom differed significantly from the fertilizer alone treatments. Regarding quality aspects when looking at the total marketable and unmarketable number of beetroots at harvest, Bontera was not able to enhance beetroot quality.

Conclusion

Bontera showed an impact in improving germination percentage and therefore, could be considered as a seed treatment to enhance establishment. Due to the lack of significant improvement of beetroot yield and quality, we recommend longer term trials with products such as Bontera to obtain accurate and repeatable results. As with any switch from inorganic to organic production, changes in the soil, soil health improvements as well as improved crop growth, yield and quality do not take place overnight.

References

Keywords:

Beta vulgaris, Bontera, Fertilizer, Growth, Quality and yield parameters

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Introduction:

Soil salinity is one of the major stresses that limit the yield of agricultural crops and jeopardize the capacity of agriculture to sustain the increasing human population (Flowers, 2004; Munns & Tester, 2008; Parida & Das, 2005). Since most soils and water that is used for irrigation contains salts they can negatively affect production. Wheat is one of the most important grain crops grown, giving about one-third of the total annual cereal production worldwide. Due to an increase in salinized areas, used for production, there is a need to increase crop yield to fill the gap between current and maximum achievable yields in order to ensure world food security (Reynolds and Ortiz., 2010). Previous studies have confirmed an increase in growth attributes with a Si application on soybeans under salt stress. Wheat is mostly tolerant at a salinity of EC 600, thus the aim of this study was to evaluate the alleviating effect of silicon, with accumulating salt levels on different growth stages.

Materials and Methods

The trials were laid out as a completely randomized block design in glasshouses of the Department of Soil, Crop and Climate Sciences at the UFS. Four desired saline conditions (0, 300, 600, 900 EC) were applied to the soil before planting using different salts and maintained at field water capacity, by watering the pots with the saline treatments. Three different silicon treatments were applied as a soil drench at planting. These included Zumsil a registered product and monosalicylic acid at two concentrations (1x and 2x). Pots were replicated 8 times, harvested every four weeks, at tillering, booting, flowering, and maturity measuring the number of ears and seeds, the weight of seeds, and fresh and dry weight of ears, above ground and root weight.

Results and Discussion

All measured parameters decreased with an increase in salinity above EC 600. The number, as well as weight of ears and seeds, showed an increase at EC 300 and 600 in combination with the monosalicylic acid (MSA) (1x and 2x), while Zumsil with the same combination increased the number of ears. MSA at both concentrations increased number and weight of the seeds, as well as the fresh and dry weight, when applied together at all three EC values.

Conclusion

The data demonstrates that wheat is negatively affected by soil salinity above the EC value of 600. The concentration and application of silicon in different forms and concentrations can alleviate these negative effects.

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Keywords:

Salt stress, silicon, growth parameters

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3	Dr. Johann A. Strauss	Western Cape Department of Agriculture, Elsenburg Department of Agronomy, University of Stellenbosch

Introduction:

Soil health is an important focus in Conservation Agriculture (CA) and refers to the ability of a soil to maintain a well-balanced ecosystem with high biodiversity and productivity above as well as belowground. There are different indicators that are used to monitor soil health, with the main focus of this study being earthworms as biological indicators. Earthworms (Subclass: Oligochaeta) are a well-known group of organisms that have received much attention as indicators of soil health, but there is still more research needed, especially in South Africa. The aim of the project was to compare earthworm abundance and diversity between different CA systems and assess their use as bio-indicators of soil health in CA.

Materials and Methods

The study was conducted on two of the Western Cape Department of Agriculture research farms namely Langgewens, outside Malmesbury and Tygerhoek, near Riviersonderend. Earthworm samples were taken using 3 different sampling techniques from different CA systems at these two sites. At Langgewens, samples were taken from a monoculture, cash crop rotation and pasture cash crop system and at Tygerhoek it was taken from a regenerative pasture and cash crop and a CA cash crop system. The three sampling techniques included hand-sorting, mustard solution and a combination of the hand-sorting and mustard solution method. Samples were taken 3 times during the year and initial results are discussed. A forth sample will still be done at the end of the season.

Results and Discussion

This poster relates preliminary results from the first three sampling dates, however data still needs to be statistically analyzed. Differences in earthworm abundance were detected between the two farms, with Tygerhoek (n=1514) showing a higher abundance than Langgewens (n=473). These differences in earthworm abundance possibly relate to the changes in soil moisture that have been observed between the seasons. There also appear to be differences between different systems at each of the two farms. The pasture cash crop (n= 240) at Langgewens and regenerative pasture and cash crop (n= 968) at Tygerhoek had the highest earthworm abundance.

Conclusion

Earthworm species diversity must still be determined and additional soil data will be taken into account to assess the worth of earthworms as bio-indicators in the Western Cape farming systems' soil health. Thus far, earthworm numbers appear to be higher in soils with higher soil moisture and this could be one of the main factors leading to differences in earthworm abundance between the two farms.

Keywords:

abundance, indicator, oligochaeta, soil moisture, species diversity

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Introduction:

Crop diversity and sequence can play an important role in the yield of cash crops in Conservation Agriculture (CA) systems. The positive effect the yield of a cereal crop following a legume has been noted numerous times in literature. The aim of this study was to evaluate the effect of different preceding crops on the yield of wheat, barley and canola over a 17 year period.

Materials and Methods

Data was taken from a long-term CA trial in the Overberg area of the Western Cape. All three cash crops form part of a series of 4-year rotation systems with all crops present in the field every year. Wheat followed legume pasture, lupines, canola, oats and wheat, while barley only followed on either wheat or legume pasture. Barley, legume pasture and wheat preceded canola. The experimental design was a randomised block design with 17 (years as) replications and crop sequences. Shapiro and Wilk test confirmed normality of the standardized residuals (Shapiro and Wilk, 1965). The data were subjected to analysis of variance (ANOVA) using the General Linear Models Procedure (PROC GLM) of SAS software (Version 9.4; SAS Institute Inc, Cary, USA). Fisher's least significant difference (LSD) was calculated at the 5% or 10% level to compare treatment means.

Results and Discussion

At the 95% confidence level the average yield of wheat following wheat was significantly lower than the average yield of wheat following the other preceding crops. However, at the 90% confidence level the average wheat yield following a legume pasture was significantly higher than the yields following wheat and canola. This differs from findings in the Swartland production area. No significant differences were noted between the preceding crop effects on barley. One would expect higher yields in barley when it follows a legume pasture. This is however not a viable option due to increased nitrogen levels in the kernels which has a negative effect in the beer brewing process. Canola following a legume pasture showed a significantly higher yield than following barley and wheat. It was expected that there will be larger differences in the average wheat yields following a legume pasture or crop than those following a cereal crop.

Conclusion

The results from this trial suggest that over the long term canola yield is more sensitive to the effect of the preceding crop than either wheat or barley in the Overberg region of the Western Cape.

Keywords:

conservation agriculture, crop performance, preceding crop effect, yield

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Introduction:

Seed dormancy is the major challenge in the cultivation of African Indigenous Vegetables. Amaranth spp and Cleome gynandra are important medicinal and nutritional crops. These vegetables are important in household food security in the subsistence farming sector and rural areas in Africa as they are consumed as relish/sauce that accompanies starchy staples such as maize porridge known variously as sadza, phuthu, ugali, nsima in various parts of the African continent. The dormancy mechanisms in these species have been reported as either physical or physiological.

Materials and Methods

The experiment was conducted at Marondera University of Agricultural Sciences and Technology farm. Geographically the experimental field is located at -18°.23'28S latitude and 31°.47'53. E longitudes at an altitude of 1668 meters above sea level. The purpose of the study was to evaluate pre-sowing treatments that break seed dormancy and improve seed emergence of Amaranth spp and Cleome gynandra. Seeds were pre-soaked in different concentrations of GA3 (0, 100, 200, 300, 400, and 500ppm) and KNO3 (0, 1%, 2%, 3%, 4% and 5%) solutions for 24hrs to have a factorial layout within a completely randomized block design replicated three times. Hundred seeds of both crops were planted per plot (1x2m) wide. The emergence percentage and vigour index of seeds treated with GA3, KNO3 and control were compared on weekly basis for fourteen days Amaranth spp and twenty-eight days Cleome gynandra ISTA 2021.

Results and Discussion

The results showed significant differences ($p < 0.01$) between the GA3 treatments. The highest emergence percentages of Amaranth spp (66.83%) and Cleome gynandra (69.06%) and index vigour (524.3, 632.8 respectively) were obtained at a concentration of 500ppm GA3 and least emergence percentages (56.50%, 56.39%) and vigour index (397.1, 468.0) respectively, were recorded in the control for both crops. Vigour index in the seedlings treated with GA3 might have been caused by high production of photosynthates (Anburani and Shakila, 2010). The new finding from this study is that problem of dormancy that is characteristic of Cleome gynandra and other semi-domesticated crops can be alleviated by treatment with GA3.

Conclusion

In conclusion GA3 enhanced emergence and vigour index of both crops. This study will be repeated for confirmation since the results are based on one season's data.

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International Seed Testing Association 2021

Keywords:

African Indigenous Vegetables, crops , pre-sowing, germination

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Introduction:

Fusarium crown rot (FCR caused by *Fusarium pseudograminearum*) is a stubble-borne disease of economic importance for wheat (*Triticum* spp.) production. Disease incidence and severity of FCR increases when wheat is monocropped. Disease management relies on combining agronomic practices like crop rotation and soil tillage with host tolerance and seed treatments. FCR is favoured by warm, dry conditions after anthesis, which makes zero tillage a valuable tool for disease management due to soil moisture conservation. The aim of this study is to determine the effect of crop rotation and tillage practices on FCR and agronomic parameters of wheat.

Materials and Methods

Research was conducted during 2020 in long-term trials at Langgewens and Tygerhoek Research Farms, located in the Mediterranean climate of South Africa. A split-plot design was followed with 3 replicates. Three cropping systems (main plot) consisted of a wheat monoculture, wheat rotated with annual *Medicago* spp and two sequences where wheat followed canola (*Brassica napus*) or *Lupinus* spp in a wheat-canola-wheat-lupin system. Each rotation system was sub-divided into four tillage treatments (sub-plot), namely conventional-, minimum-, no-, and zero-tillage. Twenty eight wheat samples were taken from each treatment at the soft dough stage to assess disease parameters including disease incidence, percentage tillers diseased, average lesion length and internode discoloration. Grain yield and quality was also assessed. An analysis of variance and principal component analyses on all parameters were performed.

Results and Discussion

Wheat planted after lupin had the shortest average lesion length at Tygerhoek ($\mu=21.8\text{mm}$). Monoculture wheat produced the lowest yield with 3286 kg ha⁻¹ at Langgewens. Wheat grown under minimum tillage had the highest disease incidence at Langgewens in 2020 ($\mu=86.0\%$), with both zero- and conventional tillage reducing FCR incidence. At Tygerhoek, zero tillage reduced the percentage tillers diseased. Zero tillage decreased the average lesion length at both Tygerhoek and Langgewens. At Langgewens, minimum tillage had the highest internode discoloration up to the 3rd internode.

Conclusion

Preliminary results show that FCR incidence and severity in the Swartland is mainly influenced by tillage practice, with minimum tillage resulting in more disease, likely due to FCR inoculum being spread throughout the field with less disturbance. With zero tillage, less stubble comes into contact with the crowns resulting in less disease symptoms. In the southern Cape, where FCR traditionally occurs more frequently, both crop rotation and tillage treatment influenced FCR parameters, with wheat planted after lupin and wheat planted under zero tillage conditions having less FCR symptoms than other treatments.

References

Keywords:

Fusarium crown rot, conservation agriculture, crop protection

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Introduction:

Coriander leaves (*Coriandrum sativum*) are an annual herb from the Umbelliferae (Apiaceae family) that originates from the Mediterranean regions and is grown worldwide. Coriander leaves are popular among consumers because of the many nutritional and health benefits and high potency in antioxidants. After harvest, the quality and the bioactive compounds are lost during storage or at the market. Therefore, the objective is to evaluate the influence of light-emitting diodes on the bioactive compounds of fresh coriander leaves, such as the β -carotene, total phenolic content, phenolic acids, volatile aroma compounds, and antioxidant activity (DPPH, ABTS, and FRAP).

Materials and Methods

The study was conducted at the Tshwane University of Technology Postharvest laboratory. The coriander punnets were kept on separate shelves fitted with LED lights in a cold room maintained at 5°C and at 85%RH. Coriander leaves (30 g) were packaged in 16 g polyethylene terephthalate (PET) plastic punnets (Length 18cm and 12cm width). Ten replicates were exposed to blue (450 nm) and red (660 nm) LED lights for 2 h and white lights or no light supply (dark) as controls. At 3 days intervals, up to 9 days, samples were removed from cold storage, snap-frozen (using liquid nitrogen), and held at -80 °C for the biochemical analysis. The data were analysed using one-way ANOVA [GenStat for Windows (2004) statistical package VSN International (VSNi), Hemel, Hempstead, UK]. Means were separated by Fishers protected least significant difference (LSD) at $p < 0.05$ level.

Results and Discussion

The red LED lights significantly accelerated the accumulation of β -carotene in coriander leaves on day 6 and then diminished it on day 9. The total phenolic content was significantly highest on days 6 and 9 under blue lights and day 9 under red lights. The red lights showed the highest concentrations of ABTS activity throughout storage (3,6 and 9 days). Furthermore, the ABTS activity was considerably increased under the blue lights on the 6th and 9th days. Coriander aroma compounds increased on day 9 under blue lights and day 3 under white lights. The red light and dark storage resulted in significantly lower volatile aroma compounds.

Conclusion

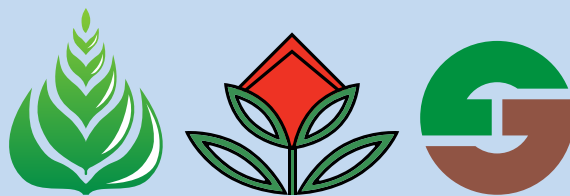
The light-emitting diodes showed to be a promising and innovative technology that can improve the bioactive compounds of coriander leaves, which ultimately translates to increased health benefits.

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Keywords:

Coriander leaves; bioactive compounds; red and blue LED lights



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