# DETECTING WETTING FRONT STRENGTHS BETWEEN SATURATION AND 9 KPA

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Wetting front detectors are simple devices that provide basic information for growers to improve irrigation management. There are currently two designs: the commercially available, funnel shaped FullStop detector, and the tube shaped LongStop detector. The funnel shaped detector responds to wetting fronts in the 0 to 3 kPa range. This study was aimed at showing that the tube design can detect wetting fronts as dry as 9 kPa, and that the level of water within the LongStop is correlated to the suction at the top of the device within the 0-9 kPa range. However, to perfect the design and improve ease of use, a material had to be selected with which to fill the LongStop that would saturate easily and has a high conductivity in the 0-9 kPa range. Very fine sand (D36) and Diatomaceous Earth (DE) were identified as good wick materials using laboratory methods. Two 90 cm LongStops, one filled with very fine sand (LS-D36) and the other with Diatomaceous Earth (LS-DE), were buried 15 cm below the surface to determine the relationship between suction at the top of the LongStop and the water level inside it as well as the percentage of wetting front detection. An automatic tensiometer and TDR probe were placed at the opening of each LongStop to monitor changes in tension and water content respectively. Wick suction was linearly related with water level ($r^2$ > 87) for LS-D36 and $r^2$ > 84% for LS-DE. During the 8 irrigation events monitored, 86.5% of the fronts with LS-D36 and 78% of the fronts with LS-DE were detected.

*Keywords:* Automatic Tensiometer, TDR, wick material, wetting front

# SCREENING GROUNDNUT GENOTYPES FOR TOLERANCE TO SOIL ACIDITY

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Soil acidity limits crop production via its influence on nutrient availability e.g. Ca, Mg, and P deficiency, or toxicity of Mn and Al, among others. The logistics and cost of liming as a tool for remediation of acid soils, are beyond the means of most small-scale farmers in the region. A study was carried out in a controlled environment growth room to investigate genotypic variation in groundnut as a tool for small-scale farmers for improving the production of the crop in acid soils.

Nine groundnut genotypes were grown in soils with acid saturation of 45%. There were four remediation treatments comprising application of lime as $Ca(OH)_2$ (1.1 g /1100 g soil), phosphorus as $KH_2PO_4$ (0.12 g /1100 g soil) a combination of $Ca(OH)_2$ (1.1 g /1100 g soil) and $KH_2PO_4$ (0.12 g /1100 g soil) and a control with no remediation.

In six genotypes, remediation with lime, P or a combination of these, increased shoot dry matter, Ca, P and Mg levels ($P < 0.05$). The treatments also concurrently reduced the shoot tissue Al, Fe and Mn concentration ($P < 0.05$) in these genotypes. On the other hand liming had little influence on the nutrient profile of the genotypes Rambo and Billy and shoot Al concentration was low even with no remediation.

*Keywords:* Groundnut genotypes, tolerance to acidity

# EFFECT OF LIGHT ON RIPENING COLOUR PATTERNS OF BELL PEPPER FRUIT (*Capsicum annuum* L.)

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The CIELAB colour system expresses colours in mathematical terms, thereby minimising the subjectivity of visual assessment. This system has been used to describe the colour of many horticultural crops, with particular reference to stage of maturity. The change in colour of a fruit as it ripens from green to fully ripe can be expressed on a continuous basis by plotting the a* b* coordinates throughout the ripening process, producing a characteristic 'colour line'. This 'colour line' can then be compared with internal characteristics of the fruit and interpreted according to the objectives of the research.

The effect of two light levels on the ripening process of yellow, orange and red sweet bell peppers (*Capsicum annuum* L.) in terms of colour change was investigated using the CIELAB colour system in the above manner. Pepper fruit on the plant was either exposed or covered with a black plastic bag.

Observed differences in colour patterns are interpreted and implications discussed.

*Keywords:* bell pepper, ripening, CIELAB, colour change

# PREDICTION OF RUNOFF FROM A BARE CRUSTED SOIL SURFACE ON THE GLEN-BONHEIM ECOTOPE

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Field experiments on the semi-arid Glen-Bonheim ecotope over seven consecutive growing seasons (1996-2003) have shown that employing the in-field rainwater harvesting (IRWH) crop production technique result in yield increases of 30-50% compared to conventional (CON) tillage. The water conservation advantages of IRWH over CON are threefold, viz. (a) ex-field runoff is zero; (b) runoff from the 2-m runoff strip is enhanced by it being flat, untilled and crusted, resulting in an accumulation of water in the protected basin area close to the crop roots; (c) because of (b) the loss of water by surface evaporation from the runoff strip and from the basin area is reduced. The extent of runoff during a growing season therefore has an important influence on the water conservation advantage of IRWH. The key factors influencing runoff (R) have been shown to be: rainfall intensity ($P_i$); final infiltration rate ($I_f$); surface storage ($SD_m$), which depends on the surface roughness; and the speed and degree of crust formation. These parameters are all included in the Morin and Cluff (M & C) runoff model. The ability of this model to predict R on the Glen-Bonheim ecotope was tested over seven rain seasons. The tests were conducted on plots with flat, bare, crusted surfaces, i.e. $SD_m$ was negligible. R and $P_i$ were measured. Half of the data was used to calibrate the M & C model and the remainder was used for validation. The calibration procedure showed that appropriate values for the M & C model on the Glen-Bonheim ecotope were: $I_f$ = 6 mm $hr^{-1}$; $SD_m$ = 0.05 mm; crusting parameter ($\gamma$) = 0.02 $mm^{-1}$. Model performance was statistically tested with the following results: D-index = 0.88; $R^2$ = 0.63; RMSEu/RMSE = 0.83. These are acceptable results. The ability of the M & C model to predict R accurately was also tested against an independent dataset. R was predicted for a period of 18 years from a flat, bare, crusted soil surface on the Glen-Tukulu ecotope. The M & C model predicted the annual R very well (D-index = 0.97; $R^2$ = 0.89; RMSEu/RMSE = 0.86). The results of this study indicate that the M & C model can be used with confidence to predict R from flat, bare, crusted soil surfaces on the Glen-Bonheim and similar semi-arid ecotopes.

*Keywords:* In-field rainwater harvesting, Morin and Cluff runoff model, surface storage, infiltration

# HERBAGE YIELD, ESSENTIAL OIL YIELD AND OIL COMPOSITION OF ROSE-SCENTED GERANIUM (*Pelargonium* SPP.) AS INFLUENCED BY LIMING

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A field experiment was conducted on rose-scented geranium (*Pelargonium* spp.) in Pretoria to evaluate plant response to liming. Treatments consisted of four liming rates of dolomitic limestone at 0 (control), 2, 4 and 6 t $ha^{-1}$. The experiment was laid out as a randomised complete block design. The oil content of the plants (sample of 10 kg from each treatment) was determined by steam distillation and oil samples were analysed by gas chromatography (GC). Soil pH was not influenced by the applied lime for any of the treatments at the time of the first harvest, whereas at the time of the second, third and fourth harvests, an increase in pH was observed for all the limed treatments. At the time of the first harvest, plants did not respond significantly to 2 and 4 t $ha^{-1}$ of liming, compared to the control. However, plants responded positively at 6 t $ha^{-1}$ with higher herbage yield compared to the control and 2 t $ha^{-1}$ lime treatments. Essential oil yield was lowest at 2 t $ha^{-1}$ when compared to the control and the other liming treatments. At the time of the second, third and fourth harvests fresh herbage and essential oil yield increased significantly due to liming, compared to the control. At these harvesting periods, the differences among liming treatments were not significant for fresh herbage and essential oil yield. Cumulative fresh herbage and essential oil yield of all harvests was high in the lime treatments as compared to the control. Soil pH above 5.5 and soil base saturation above 55% increased the production of the plant, which corresponded in this case with 2 to 6 t $ha^{-1}$ of lime application. Oil content (%) and total oil yield of the plant were not significantly affected by application of lime or by an increase in soil pH. Similarly, no significant differences were observed in the composition of the essential oil throughout the experimental period due to applied lime. The implication of this study is that optimum growth of rose-scented geranium can be achieved by application of lime when plants are grown on acidic soils but without any effect on oil content and essential oil composition.

*Keywords:* Base saturation, citronellol, geraniol, C:G ratio, oil content, soil pH

# INTRODUCTION AND EVALUATION OF GERMPLASM FOR GENETIC ENHANCEMENT OF COWPEA IN SOUTH AFRICA

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Cowpea, *Vigna unguiculata* (L.) Walp, commonly known as black eye pea, is an important grain legume in sub-Saharan Africa. It is important because it is a major source of cheap plant protein to most poor families, provides regular income to farmers for the sale of grain and fodder, and a good source of animal fodder. Further more, cowpea is important for the sustainability of soil fertility. Cowpea breeding programe began three years ago with less than 250 germplasm accessions which have low genetic variability. In order to increase the genetic diversity of cowpea genebank at ARC and enhance the speed of improvement of this neglected crop, cowpea breeding program at ARC-Grain Crops Institute (GCI), Potchefstroom, introduced many germplasm accessions from IITA, Nigeria. Evaluation of these lines will enable the breeder to determine their usefulness in the breeding programme. This paper, therefore, discusses results of 650 germplasm core accessions introduced from IITA in 2006. These accessions were evaluated at the research farm of ARC-GCI in 2006/07 cropping season using an augmented design with local adapted varieties as complementary checks. During crop growth, cowpea plots were protected from insect damage with 3-4 insecticide sprays. Data were collected on important traits which included number of days to fifty percent pod maturity, growth habit, leaf shape, grain and fodder yields as well as hundred seed weight. Results obtained indicated that there was high variability among the accessions for all the variables measured. Number of days to fifty percent pod maturity varied from 90-147 days which were classified into four maturity groups (early, medium, late and very late). Among the accessions, 171, 138, 176 and 109 accessions were selected for early, medium, late and very late cowpea types. Thirty accessions exhibited erect growth habit while 325, 277 and 14 exhibited semi-erect, prostrate and twining habits. Majority (595) of the accessions leaf shape were obvate while 54 accessions exhibited ovate shape. Grain yield also significantly varied from 1.5 – 6.0 t $ha^{-1}$. Dry fodder yield ranged between 2.0 – 8.0 t $ha^{-1}$. Seed weight between 5 g and 26 g per 100 seeds. In summary, the accessions possess significant genetic variability that will be useful for the improvement of existing cowpea genotypes in South Africa. This also, will help to meet the immediate needs of local and commercial farmers in South Africa.

*Keywords:* Fodder, germplasm, grain yield, seed weight, *Vigna unguiculata*

# EFFECTS OF WEEDING FREQUENCY ON YIELD AND YIELD COMPONENTS OF COWPEA UNDER DRYLAND CONDITIONS

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Weed control is essential for successful crop production; some losses of agricultural production could be attributed to the competitive effects of weeds. The objectives of this study were to assess the influence of weeding frequency on grain yield and yield components of cowpea, to determine the appropriate weeding level for cowpea production on the field and to compare the differential responses of the two selected cowpea cultivars to competition with weeds. Treatments comprised of four weeding levels (C0= no weeding, C1= once-off weeding, C2= two times weeding and C3= three times weeding) and two cowpea cultivars (Small drum and Black eye) were used as test crop. Treatments were arranged in 2x4 factorial experiment fitted into randomized complete block design. Weeding frequency significantly affect biomass production. The yield and yield components of the two cultivars were significantly affected by weeding frequency. For instance the grain yield observed at once-off, twice and three times weeding were 42%, 155% and 61% respectively higher than the observed value for the control (no weeding). The two cowpea cultivars differ significantly in terms of yield, biomass production and the number of nodules produced per plant. Weeding two times during the growing season is considered appropriate for optimum yield in cowpea.

*Keywords:* cowpea , weeding frequency, yield

# MANAGING ROOT ZONE SALINITY THROUGH LEACHING

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Leaching which ensures sustainable production with regard to root zone salinity and/or sodicity, has the undesirable side effect of causing salinization and/or sodification of water resources and waterlogging on a large scale. A rational management approach is therefore not necessarily aimed at minimizing the salt content in the rooting zone, but rather to control or manage salt concentrations within limits that will maintain sustainable production levels. Replacing the soil solution effectively will therefore not be entirely rational in terms of the amount of water required for efficient leaching. This paper aims to quantify the pore volume of water required to replace various soil salinity solutions with water of a constant salinity under unsaturated conditions. The research was conducted on two soils of the Clovelly and Bainsvlei form. The soils were reconstructed in 5000 litre lysimeters on the experimental farm, near Bloemfontein of the University of the Free State. A total of 30 lysimeters, 15 per soil type arranged in two parallel rows under a moveable rain shelter, were used. It was assumed that the artificially prepared soil profiles are stable because 8 cropping cycles had been completed before the commencement of this experiment. Five different salinity profiles per soil type, replicated thrice, were leached with irrigation water of 75 mS $m^{-1}$ by flooding the surface to a depth of 50 mm per irrigation event. Two irrigations per week were applied for seven weeks, which amounted to a total of 700 mm. Before irrigation started the water content of the various saline soil profiles were near the drained upper limit. The results revealed that as irrigation water enters the soil, the salt distribution patterns in the profiles changed as the residual solution was displaced and pushed from the root zone. In these soils, piston flow described the transport of the solutes. The changing pattern of salt concentration in the profile approached an equilibrium concentration equal to the salinity of the irrigation water after approximately one pore volume was displaced. Salt removed this way was assumed to be excess salts. In terms of managing salinity levels in the root zone, removing all of the excess salts will not be sustainable in the long run. The leaching curves showed that leaching the soil until 80% of the excess salts were removed, to be extremely efficient. In leaching the remaining 20% of excess salts, however, the efficiency declined rapidly as approximately one pore volume of water was needed to remove all of the excess salts.

*Keywords:* Leaching, leaching curves, pore volume, piston flow, soil water salinity

# MODELLING RUNOFF QUANTITY AND QUALITY FROM MINE WATER IRRIGATED FIELDS

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Large and intensive rainfall events on agricultural fields irrigated with saline mine water have the potential to generate saline runoff. We examined how effectively the SWB (Soil Water Balance) model could predict runoff of water and salts from such fields. SWB estimates runoff using the US-SCS curve number and assumes no interaction of runoff water with the soil. Field experiments were conducted from 2000-2006 on a loamy sand (clay 12%), a sandy loam (clay 17%) and a heavy black clay (clay 64%) soil. Maize-wheat crop rotations and pasture crops were grown on these fields. The slopes of these centre pivot irrigated fields were between 2 and 3%. Contours and waterways were designed so that runoff could exit the fields over concrete weirs. An ISCO 3700 portable sampler and salinity sensor coupled to Campbell Scientific CR10X data logger was installed at the weirs to monitor the quantity and quality of runoff. Daily weather data including temperature, rainfall, radiation, wind speed and relative humidity were obtained from automatic weather stations about 100 m from the irrigation sites. Observed runoff for the heavy clay soil field was 55 mm out of seven events of runoff. An amount of 200 mm runoff out of 57 events occurred in the loamy sand soil. In the sandy loam soil an amount of 261 mm out of 81 events was observed. Less runoff occurred from freshly tilled soil and under full canopy cover. More runoff occurred when crops were still at an early stage of development. The first event runoff produce 75% of the total runoff salts for the year as salts build up during winter. The heavy clay soil field generated 3 t $ha^{-1}$ salt runoff whereas a total of 12 t $ha^{-1}$ salt runoff was measured in the sandy loam field. The loamy sand field generated 7 t $ha^{-1}$ salts in the measurement periods. A total of 72±2 t $ha^{-1}$ salt was added to the soil through irrigation in the maize wheat rotations of the sandy loam and loamy sand soil field. The pastures grown on the heavy clay soil field received a total of 18±2 t $ha^{-1}$ salt. SWB underestimated the salt runoff. The SWB runoff subroutine was therefore improved to consider the antecedent soil water content (ASWC) and salt content of the soil surface. ASWC and salt mixing depths were added as new parameters. This more mechanistic subroutine for calculating runoff volume and quality drastically improved the accuracy of SWBs prediction of salt runoff and water. Thus, SWB output values can be used as input into a surface water model to illustrate the possible effect of large-scale irrigation on surface water resources.

*Keywords:* SWB model, Modelling, runoff, gypsiferous mine water, irrigation

# EFFECT OF SHADING ON GROWTH AND REPRODUCTIVE DEVELOPMENT OF MAIZE

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Shading reduces the total amount of radiation available for interception by the crop. It affects crop growth rate and biomass accumulation. The objectives were to investigate how different shading levels affect time of initiation and differentiation of maize reproductive structures. The study was carried out at the Hatfield Experimental Farm, University of Pretoria. Treatments consisted of three shading levels of 10%, 40% and 70% and the treatments were replicated four times. The experimental design used was a randomized complete block design. Shading was created by using black synthetic shade nets woven at different densities. Two maize seeds were planted per container of 11 litres in a coir and sand mixture. Each shading treatment consists of forty pots. Maize plants were regularly sampled, dissected and microscopically inspected to record and monitor the stages of reproductive development. Leaf areas were measured and plant tissues were oven dried to constant mass to determine the dry mass. Nine weeks after emergence, plants exposed to 90% of full sunlight had a leaf area of 4170 $cm^2$/plant, at 60% of sunlight, it was 3956 $cm^2$/plant and at 30% of sunlight, it was 3350 $cm^2$. The dry mass was 36 g, 31 g and 20 g respectively reflecting specific leaf areas of 0.116 $m^2g^{-1}$, 0.128 $m^2g^{-1}$ and 0.171 $m^2g^{-1}$. Initiation and differentiation of the reproductive structures started earlier in the 90% and 60% light treatments compare to 30% light transmission. In the 90% sunlight treatment, the tassel development was completed ahead of the other treatments and the embryonic ear was in a well-advanced stage. Respectively, the lengths of the embryonic ear at nine weeks after emergence were 15 cm, 10 cm and 5 cm. The results indicate that low availability of radiation reduces crop growth rate and development. Exposure of plants to reduced radiation delayed the initiation of the reproductive structures and reduced the reproductive structure's size.

*Keywords:* tassel, embryonic ear, specific leaf area

# STRATEGIES FOR MANAGING THE IMPACT OF NEMATODES ON THE LONG TERM PRODUCTION OF SUGARCANE

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Plant parasitic nematodes are a constraint to sugarcane production on the sandy soils of South Africa. These soils contribute more than half of the 400 000 ha under sugarcane. In most cases, a diverse community of nematode genera and species co-exist. Conventional management strategies include: the use of chemical nematicides, planting nematode tolerant cultivars, the use of organic amendments and the planting of suitable green manures between sugarcane crops. The aim of this paper is to examine two nematode management strategies (viz. cultivar selection and nematicide use) for their impact on the sustainable production of six different sugarcane cultivars at two trial sites (LM1 and LM2) on the KwaZulu-Natal north coast. Assuming a replant threshold of 40 tc/ha, some cultivars (such as NCo376) yielded nine crops compared to other more susceptible cultivars (such as N24) which yielded only two crops. In addition, growing a cultivar (such as N16) at LM2, which had a 'more pathogenic' nematode community (dominated by *Meloidogyne javanica*), resulted in three less years of economical production compared to the same cultivar at LM1. Using a nematicide had the most dramatic impact on sustainability. For example, untreated N16 yielded six crops compared to nematicide-treated N16 which was predicted to yield an economically viable crop for thirty or more years before replanting. In addition to the decline in long term production, the annual reduction in yield also contributed to a decline in sustainability. Managing nematodes to reduce their impact on the long term production of sugarcane should take all of these factors (site, cultivar, chemical control) into account.

*Keywords:* nematodes, sugarcane, impact, strategies

# EFFECT OF SILICON COATING ON POSTHARVEST QUALITY OF AVOCADO FRUIT

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Extending the postharvest life and maintaining product quality are key issues in avocado production. In order to maintain the external quality as well as to improve the external appearance the SA avocado industry currently uses waxes. However, various other coating materials are available that could result in better product quality at the final shipping destination. Recent research on silicon indicates that this element plays a vital role in fighting off fungal infections in plants while ascorbic acid, as an antioxidant, reduces browning in fruit tissue. Experiments were therefore carried out coating fruit with 50, 150 and 250mM potassium silicate. All treatments resulted in a reduction in water loss and a shelf life extension 7 and 14 days after treatment compared to the control. The external quality was not compromised by the treatment and internal quality of fruit, such as the carbohydrate and antioxidant status was improved. Therefore, new avocado fruit coating methods could be used to increase the “healthiness” appeal of avocado further.

*Keywords:* avocado, silicon, postharvest

## BENEFICIAL EFFECTS OF CONSERVATION AGRICULTURAL PRACTICES

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Conservation agriculture (CA) practices (minimum tillage, crop residue retention, crop rotation and intercropping) are being demonstrated on a commercial scale in the Qunu district of the Eastern Cape Province of South Africa. Maize and soybean are planted in rotation, and maize and *Lablab purpureus* (*Dolichos lablab*) in an intercropping system, respectively. The CA practices are being compared with a block of maize cultivated according to traditional practices. Results from the 2005/2006 growing season are discussed. Soil samples showed differences among in and between crop rows for pH, P, K and inorganic N on all treatments. Higher in the row inorganic N values for the soybean and lablab stands indicate soil N accumulation due to biological N fixation. Maize leaf analyses showed differences among treatments with the traditional stand exhibiting the lowest values. Soil water content was lowest during the early part of the season for the traditional maize block, perceivably leading to growth stress during the vegetative phase. Soil compaction was highest under the traditional practice, exceeding the threshold of 1200 kPa for maize beyond 200 mm soil depth. Seed yield (t $ha^{-1}$) was highest for the rotation maize (3.7), followed by intercropping maize (3.0) and traditional maize (2.3). Poor soybean and lablab yields were recorded. Highest gross margin was attained for the rotation maize (R2540 $ha^{-1}$ compared to R1100 $ha^{-1}$ for traditional maize).
To conclude: The measured benefits of CA indicate a sustainable approach to the management of the natural resources, while food security and wealth can simultaneously be achieved by local farmers.

*Keywords:* conservation agriculture, soil fertility, soil compaction, soil water storage, yields, gross margins

# SPATIAL DISTRIBUTION OF DIRECT SOLAR RADIATION IN THE STELLENBOSCH AND ELGIN AREAS

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The physiological functioning of plants is strongly influenced by incoming solar radiation (insolation). Some wavelengths are photosynthetically or otherwise biologically active, whilst others are not. The effect of wavelengths is primarily that of causing warming. Direct radiation is more effective than sunlight that has been reflected or diffused. Since plant metabolisms tend to operate less efficiently, and may even shut down at high temperatures, it is important that beneficial radiation should be adequate during those periods of the day when metabolism is fully active.
A consequence of these factors is that it is extremely useful to know what levels of insolation may be expected, not only during the course of the season, but also during the course of each day.
By taking into account factors such as the solar constant, aspect (slope direction), slope (angle), season and time of day it is possible to calculate theoretical (as opposed to measured) insolation intensity across a landscape, no matter how complex, and to display these data pictorially.
The purpose of this poster is to illustrate the topography-induced variation in forenoon insolation across two wine-producing areas, Stellenbosch and Elgin, at four dates from mid- to late summer. In both Stellenbosch and Elgin, insolation (all aspects) decreases progressively from mid-December to the beginning of March. Also in both areas, the insolation received by east facing slopes exceeds that by west facing slopes. In Stellenbosch, insolation on north east (NE) slopes becomes significantly greater than on south east (SE) slopes after mid-January. Insolation on north west (NW) slopes exceeds that on south west (SW) slopes after mid-December. In the Elgin area, insolation on SE slopes is higher than on the NE slopes in December, but decreases rapidly during the season. In consequence, insolation on SE slopes significantly exceeds that on NE slopes until early February. Late in February, however, insolation on NE slopes exceeds that on SE slopes. As in Stellenbosch, NW slopes at Elgin receive significantly more insolation than SW slopes after mid-December.
Geographic information systems-based models of this type have applications in terroir and demarcation work, and are likely to become more extensively utilised as global warming continues.

*Keywords:* Aspect, demarcation, insolation, season, slope, terroir

# PREDICTION OF WATER CONTENT, SEVEN-CARBON SUGARS AND DAYS TO RIPEN IN AVOCADOS USING NEAR-INFRARED SPECTROSCOPY

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'Hass' avocados were harvested at 8 different times (100 fruit per harvest) during a growing season and analyzed by reflectance near-infrared spectroscopy (NIRS) to evaluate the potential of measuring the water content and seven-carbon sugar (*D*-mannoheptulose and perseitol) concentrations and the number of days to ripen non-destructively. Equations were successfully developed using Partial Least Squares (PLS). NIRS can be used to predict water content and seven-carbon sugar concentration in whole avocados. There is potential to predict the number of days to ripen for individual fruit. Water content and seven-carbon sugar concentration are useful in predicting ripening period and storage potential, and ultimately fruit quality. NIR spectroscopy has potential to be used to grade avocados on-line to minimize the variation in ripening period and predict the potential storage period.

*Keywords:* NIR, mannoheptulose, C7, non-destructive prediction, ripening, fruit quality

# IMPACT OF COMMUNICATION CHANNELS, MOTIVATORS AND DEMOTIVATORS ON ADOPTION OF IN-FIELD RAINWATER HARVESTING

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Technology transfer is the process applied by researchers, developers and extensionists through which new knowledge, techniques, and other skills are introduced to potential users. In this case the ARC-ISCW research team at Glen was the developers of the new in-field rainwater harvesting (IRWH) technology, and the households in the communities in and around Thaba Nchu in the Free State Province were the potential users. Technology can be transferred in a variety of ways and can be broadly categorized into three groups, namely individual, group and mass. Many communication channels are available, each with various advantages and disadvantages. Therefore, the question that needs to be answered is: what are the best communication channels to exchange information and knowledge about IRWH to small-scale farmers in Thaba Nchu? The aim of this study was to evaluate the different communication channels used in order to establish “best practices” in technology transfer. In-depth interviews from a structured questionnaire were conducted with 240 households. The communication channels evaluated were: demonstration plots (group); drama (mass); video (group and mass); 3D model (group); posters (mass); focus group discussions (group); support by ARC-ISCW technicians (individual and group); and festivals (group and mass). Specific indicators for success of the technology exchange process were used. During the technology exchange process various motivators and demotivators were identified that influenced the adoption process of IRWH. It was concluded that festivals was the most successful communication channel in terms of number of people being exposed and the effectiveness of communication. The very successful technology exchange phase was the result of different communication channels used during various stages. It is therefore recommended to use a range of communication channels since the possibility of conveying the correct and intended message to an individual or group is much higher as compared to the use of a single channel. Different communication channels assist in conveying different messages to the farmers. However, it must be cautioned that even by using the best communication channels, success cannot be guaranteed without effort (hard work), passion, buy-in, excitement and a good action plan.

*Keywords:* in-field rainwater harvesting, communication channels, technology transfer

## QUANTIFYING EVAPORATION UNDER VARIOUS MULCHING STRATEGIES

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In semi-arid crop production areas of South Africa, the problem of low and erratic rainfall is exacerbated by two major unproductive water losses, viz. runoff (R) and evaporation from the soil surface (Es). R can be controlled by in-field rainwater harvesting (IRWH), leaving Es that needs to be minimized, both during the fallow and growing periods. The hypothesis was that appropriate mulching techniques would reduce Es. Field experiments were laid out on two ecotopes at Glen, one with sandy loam and the other with clay texture in the surface soil. Measurements were made for both summer and winter. Four treatments with three replications were applied on 2 m x 2 m plots, namely: (a) bare soil; (b) stone mulch covering 50% of the soil surface (S-50%); (c) organic mulch covering 50% of the soil surface (O-50%); and (d) organic mulch covering 100% of the soil surface (O-100%). Changes in soil water content were measured with a neutron water meter as well as gravimetrically. Drainage curves were first obtained and thereafter all plots were again saturated with water. Mulches were applied immediately after excess water had disappeared. Soil water losses were calculated from consecutive measurements and the drainage component deducted to obtain Es. The latter was accumulated for the period of measurement, 69 days (summer) and 52 days (winter). During the summer the O-100% treatment reduced Es on the clay and sandy loam ecotopes to 127 mm and 103 mm respectively, compared to a mean Es of 150 mm from bare soils. Smaller reductions in Es were recorded for O-50% and S-50%. Summer Es values were higher than winter values because of higher inputs of water (through summer rain) and solar energy. Although the O-100% treatment gave the best result, the surprising finding was that S-50% performed as well as O-50%. The parameter characterizing the Es process (a) used in the Black and Ritchie evaporation equations was calculated for the different treatments on both ecotopes. The determined a value (mm $day^{-0.5}$) for a bare soil on the clay and sandy loam ecotopes of 3.5 and 3.0, respectively, compares well with the mean a value from literature for a range of soils of 3.5. Alpha values for winter and summer periods should be determined which would be valuable information for crop modellers. Differences in a values for winter and summer periods could be avoided by relating Es to $SE_o$ to give an ecotope specific b value.If enough crop residues are available, a 100% residue cover is recommended to increase soil water storage and decrease Es. A S-50% mulch will probably be the best practice to recommend in the rural areas because of the scarcity of crop residues, as well as the urgent need for animal feed during winter. In order to gather reliable Es data, measurements should include at least the 0-300 mm soil layer.

*Keywords:* evaporation, mulch, drainage

# REVIEW OF THE SUSTAINABILITY OF THE IN-FIELD RAINWATER HARVESTING CROP PRODUCTION SYSTEM

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A number of studies have revealed low adoption rates of water conservation technologies or new innovations among smallholder farmers in developing areas. The reason might be that only one or two of the five pillars of sustainability were considered, instead of all five. The question that needs to be answered can be stated as follows: Is the in-field rainwater harvesting (*IRWH*) technique sustainable? It was hypothesized that the *IRWH* technique is a sustainable crop production technique that could contribute towards enhancing food security and alleviating poverty at household level. The five pillars of sustainability are: agronomic productivity, crop production risk, conservation of natural resources, economic viability and social acceptability. Short-term agronomic productivity was measured with on-station trials conducted at Glen, and on-farm trials and demonstrations on croplands and homesteads in rural communities around Thaba Nchu in the Free State Province. In these experiments the *IRWH* technique was compared with normal conventional tillage (*CON*). Rainwater productivity as the second indicator for agronomic productivity was determined using simulate long-term maize and sunflower yields obtained with the crop model CYP-SA and long-term rainfall data over 81 consecutive seasons. Simulated long-term crop yield data for different production techniques were used to draw cumulative probability functions (CPFs) to quantify the risk of crop failures. Certain physical processes and soil properties were measured to serve as indicators for conservation of the natural resources. Enterprise budgets for the *CON* and *IRWH* techniques were linked to long-term yield data (81 years) obtained using the CYP-SA model to calculate gross margins (R $ha^{-1}$). CPFs of gross margins determined over the long term were used to determine the economic viability (long-term profitability) of the two techniques. Income data from a number of farmers in rural communities were also used to determine the economic viability of the *IRWH* technique compared to *CON*. Specific “indicators” were used to monitor social acceptability of the *IRWH* technique. Applying the various criteria to test the sustainability of the two crop production techniques in the specific agro-ecological and socio-economic environment present in the rural communities around Thaba Nchu gave the following results: long-term agro-ecological and short-term socio-economic data indicated that *IRWH* was sustainable but *CON* was non-sustainable.

*Keywords:* in-field rainwater harvesting, sustainability, agronomic productivity, crop production risk, conservation of natural resources, economic viability

# VARIABLE RIPENING OF FRUIT IN AVOCADO CONSIGNMENTS

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There is an increasing trend towards supplying ripe, ready to eat avocado fruit to the consumer. In order to achieve this, pre-packers need to ripen fruit in a programmed manner, to ensure the correct state of ripeness at retail sales point. However, within a consignment or fruit which has been graded to appear the same, considerable variation in ripening rate often occurs, creating substantial logistical problems. The purpose of the study reported on, was to investigate the avocado fruit ripening physiology, with a view to identifying components which can be measured at harvest and packing, allowing for physiologically more uniform fruit within a consignment. Fruit maturity can be estimated by measuring water content at harvest. Previous work indicated a role for abscisic acid (ABA) in the process. The study tested this by infusing water or ABA into fruit immediately after harvest, and studying the ripening pattern and ethylene evolution. ABA synchronized and hastened ripening, while water in small amounts decreased ripening spread, possibly by creating more uniform water contents across the group of fruit. Ethylene evolution followed a similar pattern, suggesting that fruit water relations relate to ethylene and the ripening process. In a separate field study, fruit water content at harvest was the most important single factor explaining ripening variation. Based on the results, a suggested mechanism of fruit ripening initiation and progression is presented, together with mechanisms of evaluation on the pack line, to ensure physiologically more uniform fruit within consignments, and thus better suiting logistical requirements of pre-packers.

*Keywords:* Avocado, ripening, water content, abscisic acid

# BASIC PRINCIPLES FOR SAMPLING AND REPORTING FOR STUDIES INVOLVING THE MEASUREMENT OF CARBON SEQUESTRATION IN SOILS

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Variation in soil organic carbon (SOC) levels due to differences in soil management has been the subject of much investigation over the past decades. More recently, growing concerns relating to the consequences of increasing carbon dioxide levels in the atmosphere have intensified a focus on carbon (C) sequestration in soils. In the plethora of scientific papers emanating from investigations of this kind, a lack of uniformity in terms of sampling methodologies and reporting units detracts from the usefulness of the acquired data. In this paper, we review briefly the order of magnitude in which atmospheric C is fixed above ground and in the soil for four types of agricultural land use (sugarcane, sugar beet, cereals and plantation forestry);.as well as ,the basic principles for a correct appraisal of organic carbon and for reporting on differences in SOC. These include (i) expressing C in mass per unit of surface up to a depth of at least 60 cm, (ii) listing of the typological characteristics of the soils, and (iii) sampling of the different soil horizons by taking into account the natural existing lateral variation in their characteristics and avoiding the mixing of soil material coming from different horizons. Because soil organic matter includes fractions with a relatively quick turnover rate as well as ones with a very slow mineralization rate, the fraction of SOC that should be considered as "fixed" atmospheric $CO_2$ is evoked in the last part of this paper. In a final paragraph the question “which fraction of the crop residue may be used for energy production without compromising the capacity of the soil to stock organic carbon” is also evoked.

*Keywords:* methodology , soil management, carbon sequestration

# MANAGEMENT OF *Cynodon dactylon* IN SUGARCANE – A WHOLE FARM APPROACH

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*Cynodon dactylon* (cynodon, couch grass, kweek) is an aggressive weed in the South African sugar industry competing vigorously both with the establishment of plant cane and the regeneration of the following ratoon crops. Current control practices are effective for small-scale infestations but are difficult to implement where most of the farm area is infested. These practices include repeated application of glyphosate and / or paraquat + diuron. The objectives of this paper are to a) infer cynodon occurrence and associated yield losses at farm scale (over many fields) under current control practices, and b) propose a system for improved management recommendations on a whole-farm scale.

This was done for a case study comprising 111 fields of a commercial farm on the North Coast of KwaZulu-Natal, where a cynodon control programme was in place. Some fields still presented over 60% cynodon cover, with an associated yield reduction of 22% when compared with fields having less than 10% cynodon cover. However, a nearby on-station trial had previously demonstrated that in the absence of control measures, yields could potentially be reduced by up to 80%.

Multiple regression analyses showed a clear trend (48% of variation explained), with higher cynodon % cover on soils with lower clay content and available moisture capacity, and increasing pH. Other fields vulnerable to encroachment would have cynodon prevalent on field edges.

These results prompted the development of a system for “whole-farm” cynodon management. This entails that fields are classified into high, medium and low priority for control, based on field characteristics and benefit-to-cost ratios, calculated from the assignment of required control measures and inferred (potential) yield increases after cynodon control. The advantages of this system include enabling optimal allocation of the available limited resources, and providing seasonal continuity between control operations; hence reducing cynodon % cover and halting further invasion and spread into vulnerable fields.

Part of these results were presented in a poster presentation:
Campbell, P.L. Armstrong, D and Ogilvie, G. (2007). Developing systematic management for whole-farm infestations of *Cynodon dactylon* in sugarcane. *Proc. Int. Soc. Sug. Cane Technol.* 26: 399 - 403.

*Keywords: Cynodon dactylon*, management, sugarcane, whole farm approach

# REVISITING THE BORDER EFFECTS IN CROP TRIALS: A CASE OF SUNFLOWER

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Border effects can potentially affect the quality of data in plant breeding trials resulting in biased selections. Two types of border effects normally exist, inter-genotypic (competition of resources between two or more different genotypes) and intra-genotypic (competition of resources between plants of the same genotype). Intra-genotypic competition is more pronounced in water and nutrient stressed conditions. Similarly to genotype by environment interactions, three ways of dealing with intra-genotypic border effects are ignoring, avoiding or exploiting them. Discarding the first 2-3 plants or 30-40 cm at both ends of the each row depending on the crop has been recommended for field evaluation trials and yield calculations are normally based on net plots. In sunflower (Helianthus annuus) little attention has been paid to quantify genotypic differences regarding intra-genotypic competition and try to exploit it in either determining the appropriate row length for trials or selecting for tolerance under stress conditions. Within a non-segregating genotype if plants from the net plot do not show a marked decrease in the trait of interest compared to plants at both ends of the row, some form tolerance can then be assumed to exist in that genotype.

Data from a trial with 200 genotypes planted at Potchefstroom in 2006/7 season under rainfed condition was used to quantify intra-genotypic competition. The trial design was an alpha (0,1) lattice design with plot size of 2 rows, 4 m long and row spacing of 0.9m. Results from analysis of variance for stem diameter, head diameter, 1000 seed weight and yield showed that means of border plants were 47%, 71%, 26%, and 46% more than the plants from the net plots respectively. Genotypic differences to border effects were significant ($p<0.05$) for head diameter and 1000 seed weight showing that these two traits are easily affected by stress and hence can be exploited when selecting for stress tolerance among genotypes.

*Keywords:* Border effects, intra-genotypic competition, sunflower

# THE EFFECT OF POTASSIUM, CALCIUM AND MAGNESIUM FOLIAR APPLICATIONS ON RIND BREAKDOWN OF 'NULES CLEMENTINE' MANDARIN

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Rind breakdown (RB) is a postharvest physiological disorder developing 5-10 weeks into storage, which has a negative economic impact on exports. The first visible symptom of rind breakdown is a darkening of an oil gland followed by the adjacent tissue, leading to tissue discolouration. This physiological collapse of the gland structure occurs randomly over the fruit surface resulting in the oil leaking into the subcutaneous flavedo tissue. During 2007 an experiment studying the effect of foliar nutrient applications on this postharvest condition was conducted. Foliar applications commenced after fruit set in October and were repeated at monthly intervals until April. The nutrient applications were chosen as high and low concentrations according to industry guidelines: potassium 2 and 6%, magnesium 2 and 6% and calcium as 1 and 4%. Fruit were harvested from inner shaded and outer exposed bearing positions during 19-21 May, degreened, packed (including fungicides and wax) before being cold stored at 7.5°C. After 4, 6 and 8 weeks of storage RB incidence was scored. Thereafter the flavedo was removed to determine the total mineral content of this fruit tissue. The incidence of RB followed the familiar pattern of inside fruit having significantly higher occurrence than outside fruit. The 6% Mg treatment resulted in a significant reduction of RB on the inside fruit. The same trend was evident on outside fruit, but due to lower RB incidence the effect was not significant. These results indicate that the condition of the rind with respect to the mineral content, and especially Mg, seems to play a vital role in determining the sensitivity of the rind towards RB. The exact role of magnesium, or other minerals, in limiting RB incidence is unclear and requires further research.

*Keywords:* Citrus, postharvest disorder, nutrition, 'Clementine' mandarin, rind breakdown

# AN ORCHARD MANAGEMENT PROGRAM TO IMPROVE YIELD AND FRUIT SIZE OF LITCHI, CV. HLH MAURITIUS

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The South African litchi industry is predominantly export orientated and great interest is put into gaining high yields and marketable fruit size. In spite of profuse flowering, litchi yield is usually inadequate, mainly because of massive fruitlet drop during the early period of fruit development. Fruit size is often hampered by insufficient irrigation and fertilization during the critical periods of fruit development. Although good research has been done on various aspects of litchi production this research often does not find its way into farm management. This background in litchi production was the reason for initiating a project which combines “good agricultural practice” with research results in the area of irrigation, fertilization, use of plant growth regulators as well as other horticultural practices in order to reduce alternate bearing and increase yield and fruit size. Five management programs were developed and are compared with one another according to their effects on yield and fruit size. Three years of data have been collected and give a clear indication as to how to influence litchi cropping for more regular yield and increased fruit size. Furthermore, a software program as guideline for the management of litchi orchards is being developed, which is currently being tested on various litchi farms. This program will include phenological charts for each production area, fertilizer and irrigation scheduling according to tree requirement as well as other practices that need to be done during the year. The data is interlinked and guidelines for actions are given according to the phenological stage of the tree and fruit development. The results are presented and the software program introduced.

*Keywords:* Litchi, yield, fruit size, irrigation, fertilization, management program

# DECOMPOSITION OF BT MAIZE RESIDUES AND THEIR CRY1AB PROTEIN UNDER FIELD CONDITIONS IN CENTRAL REGION OF THE EASTERN CAPE

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Crop plants genetically modified (GM) for resistance to pests, represent a tool to decrease the amount of chemical pesticides used in agriculture. Genetically modification of crops could result in unintended effects on plant structure and function, which may have ecological implications. Effects of the Bt maize crop on decomposition of Bt maize leaf and stem residues, and the persistence of the Cry1Ab-endotoxin in the decomposing residues, were assessed in a litter-bag experiment, under field conditions. Decomposition of leaves and stems (separated) of Bt-maize (MON810) cultivar CRN 4549B, and the corresponding near isogenic maize (cultivar CRN 3549) was studied under both transgenic (DKC 78-15B) and near-isogenic maize (CRN 3505) crops. The experiment was set out in a randomized complete block design, with three replicates and six sampling periods. No difference was observed in decomposition of the residues as a result of the type of the growing crop. Transgenic residues had minor non-significant effects on decomposition patterns of the residues, with Transgenic Residue Effect (TRE) <1 for leaves and TRE >1 for stems. However, percent ash free dry mass, N and C remained decreased over time and varied between leaves and stems and between Bt maize and near-isogenic maize residues. Biomass decomposition was faster with leaves than stems for both Bt maize and its near-isogenic line. Decomposition of the maize residues could be described by a single exponential equation. There were higher levels of Cry 1Ab protein in leaves than in stems and the concentrations declined to <1% of initial levels in transgenic leaf residues under both cropping systems after 14 days of incorporation. The Cry 1Ab protein in transgenic stem residues was no longer detectable under an isogenic maize crop and had declined to about 15% under a transgenic maize crop. Bt endotoxin could no longer be detected in either stems or residues under both cropping systems at 84 days after incorporation. The study suggests that trace amounts of Bt toxin present in transgenic residues may persist longer under a Bt crop as well as with stem residues. There were no measurable concentrations of the Bt protein in soils immediately below the litter bags throughout the study. The rapid disappearance of Bt-endotoxin from residues in this litterbag experiment may imply a non-effect on soil ecological processes and nutrient cycling, which is essential in developing post-harvest management strategies of residues of genetically modified crops.

*Keywords:* Bt-protein, decomposition, genetically-modified maize, litterbag, residues

# TARO-COWPEA POLYCULTURE: A PRELIMINARY STUDY ON ORGANIC SOIL AMENDMENTS

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Taro [*Colocasia esculenta*; Amadumbe (Zulu)], cowpea (*Vigna unguiculata*) and mustard (*Brassica juncea*) are important traditional crops of KwaZulu-Natal. Taro production occurs in the coastal areas and it is generally either not fertilized or fertilized with homestead animal manure. Cowpeas have largely been replaced by drybeans, which are poorer in nitrogen fixation. Mustard is generally harvested as a wild leafy vegetable, but some species are cultivated in the Midlands . The objective of this preliminary study was to determine usefulness of worm compost as alternative organic manure for subsistence farmers and to determine the effects of cowpea and mustard in a polyculture system of producing taro. Taro and cowpea (grain and fodder types) were planted at two districts. Worm compost was used to fertilize the crops, and mustard was used as living mulch between the rows of each crop under monoculture or polyculture. There was a beneficial effect of intercropping cowpeas and taro and using living mulch, even under conditions of no compost application. Although polyculture caused a decrease in yield for both crops, there was a positive relative yield total (RYT), regardless of soil amendment. Living mulch resulted in the highest RYT of 2.21 compared with worm compost (1.57) and the control (1.46). Changes in soil mineral content in relation to soil amendment with worm compost and mustard living mulch are currently being determined. These preliminary findings suggest that taro production may be improved by a polyculture system if nitrogen fixation and soil mineral improvement from a living mulch are included.

*Keywords:* Amadumbe, Cowpea, living mulch, organic, polyculture, relative yield

# THE ROLE OF FRUIT TREES IN THE DEVELOPMENT OF AN INTEGRATED VILLAGE RENEWAL PROGRAMME IN RURAL VILLAGES OF THE EASTERN CAPE

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The aim of the project is to create an awareness of the value and the potential for the production of tropical and subtropical crops in the Eastern Cape and to develop integrated, sustainable farming systems based on high value production clusters. Furthermore the project aims to support the Department of Agriculture, local municipalities and other service providers and aid in capacity building and development of skills. It is envisaged that the introduction of tree crops will lead to increased food security in the area and ultimately to income generation and job creation. The high value crop programme was initiated in 1999 and since then these crops have been established in the area. A crucial part of the programme is the partnerships between all role players. The demand and interest has increased dramatically over the past few years and from the initial 13 sites, more than 1400 farmers have now planted 50100 tree crops spread through 47 villages. Trees planted include citrus, mango, guava, litchi, banana, avocado and macadamia. Ongoing training is undertaken on all aspects necessary to ensure that farmers are capacitated to produce high value crops as an economic enterprise. Value adding is also an integral part of the programme and will make market access easier especially in areas where infrastructure is poorly developed and fresh marketing would be difficult. Initial training in jam making, production of juice and drying have been undertaken in villages. The focus of the programme is therefore the empowerment of the homestead family unit in rural villages (with the emphasis on women, youth and the disabled). Assistance and support programmes of a technical and social nature are being developed to assist and build capacity. Scaling up of production to commercial levels can now be undertaken but must occur in conjunction with other reforms and service provision in the village, and this needs to be incorporated into the local Integrated Development Programme (IDP). Currently various role-players are involved in the design of an Integrated Rural Renewal Programme which will be implemented as a pilot project in the 47 villages currently involved in the planting of high value crops.

*Keywords:* Fruit trees, rural development, village renewal, Eastern Cape

# THE DEVELOPMENT OF ESSENTIAL OIL CROPS IN RURAL AREAS OF THE EASTERN CAPE, SOUTH AFRICA

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The aim of this initiative is to develop successful commercial growers of herbs in rural areas of the Eastern Cape. An integral part is the necessity to build capacity and develop skills in addition to the technical skills within each participating community as well as engender support by the Department of Agriculture, local municipalities and other service The introduction of herbs to the Eastern Cape was initiated during 2002. Herbs are not known in these rural areas and have therefore never been considered as a crop. From trials planted during 2005 eight villages were identified as being ready to move from the trial stage to the initial scaling up. Currently a further 10 villages are involved in on-farm trials planted in October 2006. Herbs planted include rose geranium, thyme, Melissa, rosemary, lemon grass and oreganum. The first harvests from these trial sites has begun. Rose geranium yielded between 0.19 and 0.40%. Rosemary yielded between 0.3 and 0.148%, thyme between 0.16 and 0.67%, oreganum between 0.26 and 1.32%, melissa between 0.02 and 0.05% and lemon grass between 0.27 and 0.57% essential oil. Most plantings are homestead based and it is envisaged that each village/area will deliver herbs to a single processing unit. The herbs in the Eastern Cape are all performing well and analyses of the oils confirm that an acceptable oil yield can be obtained from the plantings. Local farmers are eager to become involved and scaling up is the next step forward to ensure marketable volumes. Once volumes are sufficient, processing and value adding can be undertaken locally which will lead to development within the communities. Availability of planting material is limiting and this needs to be addressed by means of erection of nurseries in each region. This will also create jobs and generate income for each area. Herbs offer quick returns and are a high value crop due largely to the potential to add value. The marketing of a high value product from the area results in most benefits accruing to the participating communities. Many lessons have been learnt to date and a methodology for the successful introduction of essential oil crops into rural areas has been developed.

*Keywords:* essential oils, rural development, on-farm trials

# ROSE-SCENTED GERANIUM (PELARGONIUM SP.) ESSENTIAL OIL YIELD AND COMPOSITION AS AFFECTED BY ONE-MONTH IRRIGATION WITHHOLDING PERIOD

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In fresh water scarce areas, irrigation withholding at certain crop growth stages may maintain or increase the economic yield accompanied by saving water. Response of plant growth, and essential oil yield and composition of rose-scented geranium to one-month irrigation withholding period on different regrowth stages was investigated at Hatfield Experimental Farm of the University of Pretoria, South Africa during 2004-2005. No-stress (control), one-month irrigation withholding period either during the 2nd, the 3rd and the 4th month of regrowth were applied as treatments. Herbage yield was more sensitive to water withholding than essential oil yield because herbage yield showed a significant reduction when the water stress period was imposed during the 3rd month or later, whereas a remarkable essential oil yield loss was observed only when the plants were stressed during the 4th month of regrowth. Essential oil content (% oil on herbage fresh mass basis) showed increasing trends as the stress period was delayed towards harvesting, although it was not large enough to affect total essential oil yield per area. Relationship between essential oil composition and irrigation withholding was not consistent. The overall results highlighted that irrigation withholding practice on either the 2nd or the 3rd month of regrowth in rose-scented geranium would minimize irrigation cost, and save water that would be used to expand the irrigated land or transferred to other economic and social services.

*Keywords:* Pelargonium sp., essential oil yield, essential oil composition, irrigation withholding period

## A PLAUSIBLE SCENARIO OF CLIMATE CHANGE OVER SOUTHERN AFRICA

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Africa is regarded to be one of the continents most vulnerable to anthropogenically induced climate change; however, only a small number of high resolution climate change projections have been obtained for the continent using either dynamic regional climate models (RCMs) or statistical downscaling. Although there is still much uncertainty in representing the ocean-atmosphere-landmass system in atmospheric models, the interpretation of some the available projections has led to the perception that South Africa will become wetter in the east and drier in the west. In this study we present a projection from a RCM that shows that southern Africa may be expected to become generally drier as a result of enhanced anthropogenic forcing – in contrast to the perception that the region will become wetter in the east. We show that the projected decrease in rainfall has sound physical causes and therefore represents a plausible scenario of climate change over the region. Still, we point out that it remains a single estimate of future climate change over the region. There is a need to perform many more climate change modeling studies over the Africa in order to obtain a broader view of the range of potential future change.

The model used in the study is the conformal-cubic atmospheric model (CCAM) developed by CSIRO Marine and Atmospheric Research, Australia. The periods 1975-2005 and 2070-2100 were simulated. The model ran in a modestly-stretched-grid mode and had a resolution of about 60 km over southern Africa with 18 sigma-levels in the vertical. Initial conditions and SSTs were provided from a transient 1961 - 2100 simulation of the CSIRO Mk3 atmosphere-ocean general circulation model (AOGCM). In both the CSIRO Mk3 AOGCM and CCAM, observed greenhouse gas concentrations were used in simulations for the years between 1961 and 2000, whilst concentrations predicted according to the A2 SRES scenario were used to force the models between 2001 and 2100.

We show that the future climate is dominated by episodes of enhanced subsidence. In winter, frontal rain bands are displaced to the south leading to a decrease in rainfall over the southwestern Cape. In mid-summer, eastern South Africa is simulated to become wetter as a result of frequent cloud band formation over the region. However spring, the late summer and autumn is simulated to become generally drier in the east as mid-level high pressure systems displace cloud bands to the central and western interior of the subcontinent.

*Keywords:* climate change, dynamic regional climate model, cloud bands

# A STUDY OF WATER USE EFFICIENCY OF TABLE GRAPES IN THE HEX RIVER VALLEY

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In order to produce table grapes of export quality economically, irrigation must be practised conservatively without adversely affecting the crop. The highest water use efficiency (WUE) is only possible if irrigation scheduling practices lower the amount of water applied, while at the same time they increase the yield.

The aim of this research was to investigate whether current irrigation practices in the Hex River Valley are water use efficient by comparing current irrigation practices with theoretical models. The effect of cumulative irrigation on the chemical status of soil in 16 blocks was also investigated to establish whether nutrient leaching as a result of differential water use might have had an influence on yield.

Six blocks (3 dripper and 3 microsprinkler blocks) were initially selected and simulations to predict irrigation requirements were calculated using evaporation pan, SAPWAT and Vinet approaches. The results were compared with actual irrigation applied in these blocks for the 2005/6 and 2006/7 seasons. Furthermore, the WUE (kg/ha per $m^3$ water consumed) and the economic water use efficiency (EWUE) in kg production/ha for every $m^3$ water consumed were determined for each of the blocks and compared.

To investigate the effect of cumulative water use on the chemical status of the soils of 16 blocks, soil samples were taken and analysed for pH (1M KCl), EC (1:5); soluble cations and anions (Ca, Mg, Na, K, $SO_4$, $NO_3$, and Cl), ammonium acetate extractable cations (Ca, Mg, Na and K) and trace elements (Zn, Fe, Mn, Cu and B).

The irrigation requirements predicted by the different irrigation scheduling methods are variable. For Vinet, the irrigation requirement determined for microsprinkler irrigation is much higher than that determined using the evaporation pan or SAPWAT approaches. Comparison of the irrigation applied to each of these blocks does not clarify whether any irrigation scheduling takes place. Results showed a relationship between the EWUE and WUE. It has not however been verified whether this relationship is statistically significant.

Statistical analysis of the results of the chemical analysis and cumulative water application in each of the 16 blocks showed that with the available data, although there appeared to be some trends suggesting greater leaching under high levels of water application, no significant relationships existed between cumulative water use and soil chemical properties.

Large differences in WUE occur between the six blocks. WUE varies from approximately 2.5 to 6.0 kg.ha/$m^3$. Furthermore, the EWUE differs quite significantly due to the variation in irrigation scheduling practices in each of the blocks (between 9.0 and 25.0 R.ha/$m^3$).

*Keywords:* Water use

# CROP PRODUCTION PRACTICES IN SMALLHOLDER IRRIGATION – A CASE STUDY OF ZANYOKWE IRRIGATION SCHEME, EASTERN CAPE

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The small-scale irrigation sector in has generally performed below expectations with regard to improving incomes and sustaining rural livelihoods of small-scale farmers. In order to strengthen smallholder irrigation performance at the local level, there is need to understand farmer crop production practices and how they relate to the observed performance. A monitoring study was conducted in Zanyokwe on a sample of 43% of farmers during the 2005/06 and 2006/07 summer and winter seasons to investigate crop production practices by farmers. Ninety-two percent of farmers farmed full-time and the average size of arable land was 4.2 ha. Fifty six percent of farmers owned the land they farmed on a freehold basis while 45% leased from quitrent owners who did not make use of it. Farmers did not fully utilise their land resulting in average cropping intensities of 50%. The most active farmers in both seasons were those who did not own land and these tended to achieve higher cropping intensities. Women farmers, all of whom were widows, constituted only 11% of the sample in both seasons. Though no purposive crop rotation was practiced, farmers generally practiced butternut-cabbage and maize-cabbage rotations. Maize, butternut and sugar beans were the main summer crops while cabbage was the main winter crop. Late planting, poor crop stands and poor weed, water and fertiliser management tended to limit productivity. Mean yields obtained were 1.8 t/ha (grain maize), 8.1 t/ha (butternut) and 0.35 t/ha (sugar beans). Lack of stable markets limited choice of crops grown and most farmers opted for contract farming with the Massive Food Project (maize and sugar bean) and Pick ‘Pay (butternut). The success of both contracts was limited due to a number of reasons including farmers failing to meet quality and quantity requirements, late delivery of inputs from suppliers, long distance to markets and late payment to farmers. These results suggest that the poor performance of the scheme is a result of an interaction of institutional and technical factors. Participatory on-farm trials on water, fertiliser, weed and plant population management are being conducted in the scheme in order to come up with sustainable best management practices which can be adopted by farmers.

*Keywords:* smallholder, weed control, markets, plant stands, poor yields, fertilisers

# FORAGE YIELD AND WATER USE OF ANNUAL RYEGRASS AS INFLUENCED BY IRRIGATION REGIMES

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Annual ryegrass (*Lolium multiflorum*) is one of the most widely grown cool-season grasses in South Africa. Water shortage is the main limiting factor for the production of this pasture. This can be improved by using a proper irrigation scheduling method. Therefore, the objective of the research was to examine forage yield and water use of annual ryegrass at different soil water regimes. Response of annual ryegrass to different irrigation frequencies was investigated under a dragline sprinkler irrigation system. The field experiment was conducted at Cedara, in KuwaZulu-Natal Midlands. Annual ryegrass was planted in March 2007. Treatments were arranged in a randomized complete block design with three replications. These consisted of three irrigation frequencies, namely: high (once a week), medium (twice a week) and low (once every two weeks). Plots were irrigated to field capacity at the specified intervals and nitrogen was applied after each cutting. Pasture was harvested at the three leaf stage at a height of 50 mm above the ground. Both forage yield and water use responded to irrigation frequency. For all cuttings, higher yield was produced from the most frequently irrigated treatment. Yield and water use of different irrigation treatments varied among seasons. Hence, the choice of each irrigation frequency is largely dependent on the climatic conditions of individual seasons.

*Keywords:* Annual ryegrass, forage yield, irrigation, water use

# EFFECT OF CROP LOAD ON ‘CRIPPS’ PINK’ FRUIT QUALITY

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Crop load has a significant effect on fruit quality and the future productivity of apple orchards. The optimum fruit load balances yield and quality, resulting in regular high yields and higher profits. The objective of this trial was to determine the effect of crop load on ‘Cripps’ Pink’ fruit quality. Ten-year-old ‘Cripps’ Pink’ apple trees on M793 rootstock were hand thinned on 29 November 2006 to establish five different crop loads ranging from 137 to 99 ton per hectare. Samples of 25 fruit per tree were taken on each of three harvest dates: 18 April, 2 May and 7 May 2007, while the rest of the fruit were pooled per treatment and graded commercially for comparison with sample results. Sampled fruit were analysed for maturity, fruit colour, sunburn and size. As were expected, average fruit diameter and mass increased with decreasing crop load, from 67 mm and 135 g at 137 ton per ha to 69 mm and 148 g at 99 ton per ha. Fruit firmness, total soluble solids (TSS) and acidity and the acidity to TSS ratio increased with a decrease in crop load, whereas the percentage starch conversion and sunburn was not affected. Higher crop loads delayed the average harvest date. The higher firmness of fruit at 99 ton per hectare could be due to increased density of the fruit. Although, the percentage first class fruit did not differ significantly between treatments, undersized and poorly coloured fruit tended to increase with an increase in crop load. The higher acidity and TSS levels and the higher acidity to TSS ratio at lower crop loads may improve the taste of fruit. The effect of crop load on vegetative growth, return bloom and the storability of fruit still need to be assessed.

*Keywords:* ‘Cripps’ Pink’, ‘Pink Lady’, yield, quality, maturity

# THRESHOLD VALUES FOR POTASSIUM IN MAIZE PRODUCING SANDY SOILS OF SOUTH AFRICA

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South African maize farmers apply only two thirds of the potassium (K) which is annually removed in the grain, causing a deficit of more than 13 000 tons K per season. It is expected that these maize fields will gradually become depleted and more K will be required to maintain or improve yields. Research goals were set for the sandy soils in the main maize producing areas of South Africa to determine; the lower and upper threshold values for soil K, to estimate the K status of these soils and to select the Free State Province as a target area to evaluate the sufficiency level concept for K at various localities.

Field experiments were conducted at nine localities during four consecutive seasons. The experimental data included the soil K extracted with $NH_4OAc$ and the relative maize yields (RY) of the treatments, +K which received macro, secondary and micro nutrients and 0K which received the same nutrients but K was omitted. The results indicated a lower threshold value of 125 mg K $kg^{-1}$ and an upper threshold value of 190 mg K $kg^{-1}$. Below 125 mg K $kg^{-1}$ maize is expected to respond and above 190 mg K $kg^{-1}$ not to respond to additional K.

The extractable K from approximately 25 000 sandy soil samples received from maize farmers indicated that approximately 50% of these samples contained less K than the lower threshold value, approximately 30% was between the lower and upper values and the remaining 20% was above the upper threshold value and will not require additional K.

*Keywords:* Relative yield, maize, potassium, sufficiency, threshold values

# WEED CONTROL EFFICACY OF TWO COVER CROP MANAGEMENT PRACTICES APPLIED TO SELECTED GRASS AND BROADLEAF COVER CROPS ESTABLISHED IN A CHARDONAY/99 RICHTER VINEYARD.

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An increasing number of weed species are developing resistance to herbicides and even to groups of herbicides with different modes of action. Cover crop management is a non-specific biological method of pre-emergence weed control, which has many advantages. This study was carried out to determine the effect of two management practices on the weed control efficacy of eight selected cover crop species, with the objective of supplying the wine grape industry with guidelines for sustainable cover crop management in vineyards established on medium textured soils in the Coastal wine grape region. The trial was conducted over a period of 10 years (1993/94 to 2002/03) on a medium textured soil in a Chardonnay/99 Richter vineyard near Stellenbosch (33°55'S, 18°52'E), situated in the Coastal wine grape region of the Western Cape. Sixteen treatments, consisting of three grain species and five N-fixing broadleaf species managed according to two cover crop management practices, were included. These treatments were compared to a control treatment, in which no cover crop was sown and the weeds were controlled mechanically in the work row and chemically in the vine row from the first week of September to the end of March (grapevine growing season). A treatment in which no cover crop was sown and full surface post-emergence chemical control was applied during the grapevine growing season was also included. The different weed control actions were carried out during the first week of September and/or at the end of November, as well as mid October (1999/00 to 2002/03). *Secale cereale* L. v. Henog (rye), *Avena sativa* L. v. Overberg ('Overberg' oats), *Avena strigosa* L. v. Saia and *Vicia faba* L. v. Fiord (only if sown annually and controlled chemically before bud break (BB)), showed the ability to produce, on average, significantly more dry matter during winter than the weeds in the region. The dry matter production of all the cover crops increased from the end of August to the end of November if left to complete their life cycles, with the exception of rye and 'Overberg' oats sown in early April. None of the cover crop species were able to re-establish successfully. Continuous effective suppression of winter growing weeds (less than 20% of the weed stand in the control) was achieved with 'Overberg' oats (BB) and 'Saia' oats (BB), while total suppression was achieved for six and five of the 10 years, respectively. Effective, long-term control of the summer growing weeds was obtained with rye (BB), 'Overberg' oats (BB) and 'Saia' oats (BB).

*Keywords:* Cover crops, weed control, grapevines, management practices

## SPATIAL VARIABILITY OF SELECTED SOIL PROPERTIES IN SOIL MAP UNITS

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Soils vary at all levels of observation. Typically, when describing soil properties - whether physical, chemical, we initially think in terms of homogeneous material. This is a good starting point, because it simplifies concepts and leads to results with the least number of complications. However for characterizing the land use ability of a certain soil body it is necessary to consider variability within and between soil bodies as soils vary significantly over a land and within a homogeneous soil. The combinations of knowledge about soil inter-relationships and the representation of the soil variability will be useful in the process of characterizing the variability of soil properties for different land use abilities such as for precision agriculture. The modelling of spatial variation as well as the interpretation of the visual image will effectively determine the reason why soil bodies vary in land use abilities. The aim was to justify that the soil map is in fact a useful spatial representation of soil variation in this field. A 55 Ha land on the experimental farm of the University of the Free State, Paradys. The experimental site was sub-divided into 75 plots that were separately analyzed and treated. A thorough soil survey was done on a 50m grid and each of the 75 plots was chemically and physically analyzed for Ca, Mg, Na, K, P, pH ($H_20$), pH (KCl) and particle size distribution. Inverse distance weighting (IDW) was used to predict parameter values in areas where data was deleted to calculate the degree of accurate prediction in a certain area which could then be an indicator of the amount of spatial variation in a certain area. In the Tukulu soil body the degree of accurate prediction varies from 98.87% (Clay content (%), B horizon), which is an indication that the specific property has a low variation within the soil body to a low degree of accurate prediction of 51.52 % (P (ppm), B horizon), which is an indication that the Na has a high spatial variation within the soil body. The degree of accurate prediction between soil bodies (Tukulu/Sepane, B horizon) varied from a high degree of accurate prediction of 96.84% (Depth (mm), B horizon) to a degree of low accurate prediction of 264.15% (K (ppm), B horizon). It is concluded that the variation in soil properties within soil bodies (map units) is less than between soil bodies. Production in map units varies to the extent that land use can be improved with delineation in soil series.

*Keywords:* spatial variability, soil properties, soil map units, inverse distance weighting, soil series

# GENETIC ANALYSIS OF MAIZE STREAK VIRUS (MSV) RESISTANCE IN DWARF MAIZE VARIETIES

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Maize Streak Virus (MSV) is the most widespread biotic constraint to maize (*Zea mays L*.) production in Africa, and may lead to total crop loss in susceptible varieties. Currently available dwarf maize varieties have limited resistance to MSV. Use of resistant cultivars is the most efficient and economic way of controlling MSV, especially for smallholder farmers who cannot afford chemical control. This study was carried to determine the mode of inheritance of resistance to MSV in dwarf maize inbred lines. A six parent half diallel cross was generated using four tolerant and two susceptible dwarf maize inbred lines. The resulting fifteen single-cross hybrids were planted in a completely randomized block design with three replicates. The genotypes were artificially inoculated with MSV infested *Cicadulina mbila* leafhoppers, followed by scoring for MSV disease development at flowering. Significant variation ($P < 0.05$) was found among the crosses for MSV. This variation was attributed to both GCA and SCA effects which were both significant ($P < 0.05$). The preponderance of the GCA was shown by the GCA to SCA variance ratio of 2.84. This suggested that though additive and non-additive gene action was involved in the transmission of resistance to MSV in the dwarf maize inbred lines, additive gene action was of major importance. A relatively high narrow sense heritability value of 71% was obtained, further confirming the additivity of gene action. Progress can therefore be made by utilizing breeding methods that can fully exploit additive gene effects, such as recurrent selection. Backcrossing can also be effectively used to convert susceptible lines to tolerant ones. Some high yielding MSV tolerant single-cross hybrids were identified and recommendations were made for further trials to be conducted with these materials because of their potential for release as successful varieties. These experimental single-cross hybrids had yields of more than 8 t $ha^{-1}$.

*Keywords:* Maize streak virus, resistance, general combining ability, specific combining ability, diallel cross

# MONITORING TWO-DIMENSIONAL SOIL WATER DISTRIBUTION OF A JATROPHA-KIKUYU ALLEY-CROPPING SYSTEM

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Water is a fundamental plant growth resource. Its distribution in alley-cropping differs from that of monocropping, due to the tree-crop interactions in alley-cropping. The objective of this study was to monitor two dimensional soil water distributions across the tree-crop interface. The experiments were carried out on a Jatropha (Jatropha curcas L.) - kikuyu (*Pennisetum clandestinum*) sylvopastoral trial at Ukulinga Research Station of the University of KwaZulu–Natal. Hourly soil water measurements were made using TDR systems, in three different treatments having a constant tree density of 1100 trees $ha^{-1}$. These treatments were: Jatropha-only (tree spacing 3 m X 3 m); single Jatropha rows with kikuyu (alley width 5 m); and double Jatropha rows with kikuyu (alley width 6 m and tree spacing 2.5 m X 2 m). TDR probes were installed orthogonally to the mid-points of the alleys on both sides of the Jatropha rows, at soil depths of 0.05, 0.15, 0.25, 0.40 and 0.60 m. In the Jatropha-only treatment, a horizontal distance of 0.75 m was used. In the single Jatropha row with kikuyu and double Jatropha rows with kikuyu treatments, horizontal distances of 0.83 m and 1 m were used, respectively.

In all treatments, soil water contents generally increased with soil depth. Patterns of soil water at equal distances on each side of tree were generally similar in all treatments. The linearity ($R^2$) of soil water measurements at each inter-row pairs plotted against each other was used to check if soil water distribution was symmetrical. Values of $R^2$ of Jatropha-only treatment ranged from 0.51 at the 0.75 m distance to 0.78 at the 1.50 m distance. For the single Jatropha row with kikuyu treatment, the range was between 0.28 and 0.62 at the 0.83 m to 2.50 m distances, respectively. Values of $R^2$ in the double Jatropha rows and kikuyu treatment ranged from 0.25 at a horizontal distance of 1 m to 0.94 at a distance of 4 m. The distribution of soil water coincided with solar radiation distribution patterns, which were less symmetrical close to the tree rows than toward the mid of the inter-row spacing. It is concluded that in all of the treatments, soil water distributions were more symmetrical away from the tree rows, mainly due to the distribution patterns of solar radiation.

*Keywords:* Alley cropping, symmetric distribution of soil water, tree-crop interface

# EFFECTS OF GOAT MANURE AND PHOSPHATE ADDITION ON SOIL INORGANIC AND MICROBIAL BIOMASS P FRACTIONS AND THEIR RELATIONSHIP WITH DRY MATTER YIELD

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The effects of combined applications of goat manure and inorganic phosphate on P availability and P uptake by maize was investigated in a glasshouse pot experiment. Four rates of goat manure (0, 5, 10 and 20 t $ha^{-1}$ dry weight basis) and four rates of P (0, 90, 180 and 360 kg P $ha^{-1}$) were applied to 7 kg soil portions and maize sown immediately thereafter. Resin P, soil microbial biomass P, 0.5 M $NaHCO_3$ and 0.1 M NaOH extractable inorganic P ($P_i$) concentrations were determined at the 6th and 12th week after maize planting and related to dry matter yield and P accumulation in plants. Biomass P was significantly increased by up to 20 t $ha^{-1}$ with each increment of goat manure but manure addition had no effect on resin P, $NaHCO_3$–$P_i$, or NaOH–$P_i$ fractions. Addition of P significantly increased the P concentration in all P fractions and followed the order NaOH-$P_i$ >> resin P > biomass P > $NaHCO_3$–$P_i$. A significant (manure x P rate) interaction was observed in all P fractions at 12 weeks after planting. Resin P was decreased by 56 to 68% between the 6th week and the 12th week of sampling and was the most depleted fraction. Dry matter yield was significantly ($p=0.05$) correlated with the different P fractions. The predictive equation for maize dry matter yield was: DM (g) = 1.897 biomass P + 0.645 resin P ($r=0.733$). The synergistic benefits to maize growth realized with co-application of lower rates of goat manure with inorganic P, indicate the potential of goat manure application in the manipulation of the microbial biomass to improve P cycling and increasing the effectiveness of added P in crop nutrition.

*Keywords:* Goat manure, biomass P, resin-P, NaHCO3-Pi, NaOH-Pi, dry matter yield

## PATHWAY TO SUSTAINABLE APPLE FRUIT PRODUCTION SYSTEMS

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South Africa is a key southern hemisphere apple producing country. Together with Chile, Brazil, Argentina, Australia and New Zealand, local growers compete in the fruit markets of Europe, UK, North America and the Far East. Fruit production technologies have become aligned with the protocols and trade requirements set by these markets, i.e. Good Agricultural Practice accreditation. Consumers show grave concern on food safety and environmental issues. Sixteen percent of the RSA apple crop is produced in the Langkloof valley by mainly family owned farm and packhouse business operations. A research survey was conducted to determine sustainability indicators and criteria which may characterise a pathway to site-specific sustainable apple production in the valley. Performance relative to each indicator was benchmarked per farm and between farms over 5 production seasons. Indicators of strong earning potential are high farm yields (>40t/ha) with high packout (>80%) and fruit size (>60% in counts 70-120/18.5 kg). Cost structure and debt cost ratios are indicative of low cost management and effective cultivar mix. Ecological impacts were measured by IPM score and application rates of crop protection and fertiliser materials. Education, skills training and receptiveness to technology transfer are used as social indicators. Growers identified conservative financial management, productivity and attention to technical detail as key control factors in a sustainable farming systems.

*Keywords:* apple production, Langkloof valley, sustainability matrix, technology advances, technology transfer

**INDUCTION OF POLYPLOIDY IN *Artemisia annua*, A HERB WITH ANTI-MALARIAL PROPERTIES**

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A dependable supply of ACTs (artemisinin-containing therapies) is crucial for preventing hundreds of thousands of deaths each year from falciparum malaria, the deadliest form of the disease. Falciparum malaria causes as many as 400 million infections a year and at least a million deaths, some 80 percent of them in sub-Saharan Africa.

Since 2001, 51 countries, 34 of them in Africa (including South Africa), have followed WHO's recommendation that they adopt ACTs as the first-line treatment for malaria. Eighteen countries adopted them in 2004 alone. The resulting surge in demand - from 2 million treatment courses in 2003 to 30 million courses in 2004 and 70 million treatment courses for 2005 - led to a shortfall of artemisinin and ACTs, which WHO announced in November 2004. One key strategy is increasing the cultivation of *Artemisia annua*, particularly genotypes containing high artemisinin content.

The overall aim of the investigation is to develop high artemisinin-producing selections of *Artemisia annua* for establishment, cultivation and oil extraction. Artemisinin is an active ingredient efficacious against drug-resistant strains of *Plasmodium*, the malarial parasite, however, artemisinin production by *A. annua* is usually very low, in the range of 0.01% to 0.4%.

Seeds of *Artemisia annua* were treated with colchicine ranging in concentration from 0.01 g/l – 2.0 g/l. The seeds were treated (a) overnight and (b) for three days before being transferred to a germination medium *in vitro*. A micropropagation protocol for *Artemisia annua* was also developed. The effect of colchicine application on germination rate, polyploid induction and various morphological and physiological characteristics of plants were investigated. The results of the investigations will be presented.

*Keywords:* Artemisia, Development, Malaria, flow cytometry, polyploidy

## SUSTAINABLE PRODUCTION AND HARVESTING OF ALBERTINIA THATCHING REED (*Thamnochortus insignis*)

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*Thamnochortus insignis,* a fynbos restio specie, is the traditional thatching reed used as roofing material in Cape Dutch architecture. This specie is confined to the coastal dune fynbos stretching from Gouritz river to the Breede River in the southern Cape region. Indiscriminate destructive harvest of reed tussocks is the standard method used to gather the crop. Due to the high demand for thatching restio, neither quality control nor environmental measures are implemented in order to sustain this specie in the natural veld. Framers have reverted to mechanical injury interventions to emerging fynbos pioneers in order to create a dominance of *T.insignis* on these dune soils. These harvest practices have a negative impact on the seed mass returned to the environment. Furthermore, re-establishment of natural populations is dependent on the amount of viable seed shed by mature plants. The purpose of this study was to investigate the economic, environmental and social impact of transplanted and cultivated thatching reed harvests on abandoned farm lands as a sustainable alternative to the traditional growing and harvest methods. The project consists of two components, a Delphi technique questionnaire, to determine size of the industry and supply chain linkages and secondly, statistical analyses of actual harvests from field plots (4 x 50m$^2$) on three different sites. The experiment was replicated in natural, mechanically damaged veld and cultivated reed, respectively. Harvest data was collected in terms of number of harvestable tussocks, tussock circumference and number of thatching reed bundles per tussock. Gross income per treatment was determined on the basis of prices paid during 2006. Yield productivity was determined as a measurement of production system sustainability. Plant density is an important factor in determining yield. Yield and economic results from the cultivated lands were significantly different from those obtained by indiscriminate harvest of the two veld systems. The cultivated lands also produced a significantly higher number of saleable units as determined by the market-ready quality guidelines, as developed in this study. These results provide direction for a transformation in the thatching reed industry to a sustainable farming system which will relieve pressure on harvest from natural or manipulated coastal dune fynbos, which is under severe degradation due to land clearing, residential / recreational developments and overgrazing.

*Keywords: Thamnochortus insignis*, Albertinia thatching reed, quality standard, coastal dune fynbos, sustainability

# EFFECTS OF CULTURAL PRACTICES ON COMMON BEAN PRODUCTION: EVOLUTION OF DISEASE PRE-DISPOSING WEATHER PARAMETERS

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Knowledge of weather changes guides disease forecasting and management. Effects of irrigation method and planting date on bean production were evaluated at a high disease (ALS) pressure field. The trial was a split-plot arranged as RCBD with 4 blocks and 4 reps per treatment; the main plot factor – irrigation (IR) (2 levels sprinkler and furrow), planting date (PD) the subplot factor (3 levels early - Oct/Nov; mid - Dec; and late - Jan onwards). Hourly rainfall, temperature, RH and daily evaporation values were recorded. Durations of water applied, temperature and RH (based on levels ³ 0.1 mm, ³ 16 $^{o}$C and £ 28 $^{o}$C, and ³ 90 % , respectively) were calculated every 2 wks to 12 wks after planting. Out of 22 weather parameters, PD was significant ($p<0.05$) for 81.8% of them, PD x evaluation period 72.7%, evaluation period 45.5 % and IR 9.1%. Duration of water applied and of the water x temperature interaction was higher for furrow than for sprinkler irrigation. Duration of temperature differentiated only planting dates; humidity evaluation periods within planting dates. Water x temperature differentiated evaluation periods within planting dates. These variations were corroborated by data on disease initiation pressure and progression, crop defoliation, yield and seed quality.

*Keywords:* common bean, weather parameters, irrigation method, planting date

## RESISTANCE BY THE STEM BORER, *Busseola fusca* (FULLER) TO BT-TRANSGENIC MAIZE

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Reports of severe damage caused by the African stem borer, *Busseola fusca* (Fuller) to Mon810-transgenic maize (Bt) prompted a study in which the survival of progenies of diapause larvae collected from both a Bt and non-Bt planting were compared when feeding on various Bt and non-Bt hybrids. Field and greenhouse grown plants were artificially infested with neonate larvae. Larval mass was recorded at two-day intervals for three weeks. Data were subjected to simple regression analyses followed by pair wise comparison of the slopes. The two borer populations showed similar larval mass gains on non-Bt hybrids but differed in the response to Bt-hybrids. Appreciable numbers of larvae from the non-Bt derived population survived only to the eighth day. In contrast, substantial numbers of larvae of the Bt-derived population survived over the entire trial period. The mean larval mass of the Bt-derived population at the conclusion of the experiment was less on Bt-hybrids than on their susceptible counterparts. This indicates that the Bt-derived population has attained a level of resistance where some larvae are able to survive in the presence of the Bt-toxin but not without some detrimental effect on larval growth rate. Since producers are inclined to provide refugia under rain fed conditions in the immediate vicinity of irrigated plantings rather than as part of irrigated fields, the known preference of moths for high humidity could have contributed to increased selection pressure towards the development of resistance to the Bt-toxin.

*Keywords:* Bt-maize, field resistance, stem borers

## DISTRIBUTION AND QUANTIFICATION OF *Fusarium verticillioides* IN SOUTH AFRICAN MAIZE AND ITS EFFECT ON GRAIN QUALITY AND TOXICITY

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The maize pathogens *Fusarium verticillioides* and *F. proliferatum* produce fumonisins that cause mycotoxicoses of humans and animals. Accurate quantification of mycotoxins is essential for determining the safety of grain used for consumption. The natural frequencies of *F. verticillioides* and *F. proliferatum* and concentrations of fumonisins in local maize were studied. Sources of variation in the identification of *Fusarium* spp. and quantification of fumonisin concentrations included enumerator, number of replicates, sub-sample size and toxin detection techniques used by independent laboratories. Maize sub-samples from grain silos at 23 localities were collected and 250 kernels were aseptically plated onto rose bengal-glycerine urea (RbGU) media. Isolates were transferred to split plates containing Carnation Leaf Agar (CLA) and Potato Dextrose Agar (PDA) for identification. Inter-enumerator reliability was determined by regressing fungal identifications of *F. verticillioides, F. proliferatum* and *F. subglutinans* made by three enumerators against one another. Number of replicates was studied using 25 g samples with 5-replicate increments from 5 to 25. Sub-samples sizes were increased by increments of 25 g, from 25 g to 1000 g. Replicate studies were then repeated using greater sub-samples (250g). Three replicates of the maize samples were sent to three independent laboratories viz. ARC-GCI (ELISA), Medical Research Council (MRC) and SGS Laboratory Services (both HPLC) for quantification of toxins. *F. verticillioides*, *F. proliferatum* and *F. subglutinans* were isolated from all locations with mean isolation frequencies of 35.1%, 7.4% and 3.2%, respectively. Identification of *Fusarium* spp. by three different enumerators was reliable and accurate and low variation was detected on all media. Increasing the number of replicates using 5 g samples did not significantly reduce variation but did reduce variation ($R^2$=0.82**) when a 250 g sample was used. Sample size significantly reduced the coefficient of variation but it had no effect on standard deviation. An increase in detected fumonisin concentrations was recorded when increasing sample size from 25 to 200g ($R^2$=0.64*), as well as the number of positive samples recorded ($R^2$=0.81), with no subsequent improvement in detection efficiency. Laboratory analyses indicated that ELISA reactions correlated significantly with HPLC results of the MRC, but neither of these data correlated with results from SGS. Concentrations detected by using ELISA were consistently higher by approximately 33% than data from the HPLC technique. Quantification technique, sample size, replicate number and the laboratory where analyses are conducted all appear to be important sources of variation in the quantification of fumonisins.

*Keywords: Fusarium verticillioides*, maize, ELISA, HPLC

# THE EFFECT OF DEGREE AND DURATION OF WATER SATURATION ON SELECTED REDOX INDICATORS

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Various studies have been conducted into redox potential (Eh), redox indicators and the measured soil water contents in soil. Although a measure of success has come from these studies, there are still vast knowledge gaps in this field.
The degree of water saturation where reduction in the soil is initiated, cannot be determined from literature although it was hypothesised that 70% of water saturation ($S_{0.7}$) was sufficient to initiate reduction. This value will vary for soils at different bulk densities as well as soils with different organic matter contents.
This study was aimed to determine the effect of different degrees and durations of water saturation on reduction. Reduction was determined as a decrease in Eh of a soil and an increase in the soluble $Fe^{2+}$ concentration.
A yellow-brown apedal B horizon from profile 234 in the Weatherley catchment, Eastern Cape, was used in this study. A soil core experiment was carried out to determine the effect of degree and duration of water saturation on pH, Eh, $Fe^{2+}$ and $Mn^{2+}$. Soil cores were packed to a bulk density of 1.6 Mg $m^{-3}$ and individually saturated to $S_{0.6}$, $S_{0.7,}$ $S_{0.8}$ and $S_{0.9}$ (60%, 70%, 80% and 90% of the pores saturated with water, respectively). All measurements were done in triplicate. The cores were sealed with a double layer of plastic wrap and stored in a laboratory at 23°C until needed. Analysis started three days after initial water saturation. A set of cores (four degrees of saturation with triplicates of each) were analysed every 3.5 days for the first three months and then once a week for the remaining month of analysis. The experiment was terminated after 121 days.
A meaningful correlation was found between an increase in degree of water saturation and Eh – expressed as pe – ($R^2$ = 0.95), $Mn^{2+}$ ($R^2$ = 0.91) and $Fe^{2+}$ ($R^2$ = 0.92) concentration. Eh, pH, $Fe^{2+}$ and $Mn^{2+}$ were all significantly influenced by duration of water saturation. It was confirmed that this soil investigated, with 0.22% organic carbon had sufficient substrate to facilitate reduction and the formation of morphological features.

*Keywords:* degree of water saturation, duration of water saturation, iron, manganese, redox

# MODELLING SUGARCANE RESIDUES – PROGRESS, PROBLEMS AND POTENTIAL

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Sugarcane crops generate large amounts of dead leaf biomass, known as ‘trash’. The structure of sugarcane milling in South Africa makes it necessary to remove the trash from the plant prior to delivery to the mill. In recent decades, the conventional practice has been to remove trash using fire: the dead leaf material burns away, leaving 'clean' stalks that merely need to be base-cut and topped prior to loading. Trashing is the practice of cutting away the dead leaf material and leaving it on the field. In general, the effects of a trash blanket are considered to be agronomically beneficial; it is not, however, always clear whether or not the benefits to trashing outweigh the higher costs of this management practice. The South African Sugarcane Research Institute (SASRI) has developed a sugarcane trash-mulch model for helping to quantify some of the agronomic effects of a trash blanket in specific circumstances. The model simulates decomposition and settling of trash, and the effects of trash on soil temperature, rainfall interception, runoff, infiltration, soil surface evaporation and drainage, on a daily timestep. Comparisons of modelled and measured soil water contents and soil temperatures using datasets from Fairview in the KZN Midlands, the BT1 trial in Mount Edgecombe and lysimeter trials in Komatipoort provide insight for model improvement as well as affording a measure of model performance. Model development is subject to a number of tradeoffs between the desire for theoretical perfection and the reality of practical limitations, particularly those imposed by the target platform for this model, the Canesim sugarcane model (for example, the use of daily rather than hourly weather data inputs). Within these constraints, model performance is admirable.

*Keywords:* trash, modelling, simulation, model, validation, evaluation

## HONEYBUSH – FROM THE WILD TO COMMERCIALIZATION

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Honeybush (*Cyclopia* spp.) is endemic to the Western and Eastern Cape Provinces of South Africa, occurring naturally in the fynbos area from West Coast to Port Elizabeth. It is used as a herbal tea with health promoting properties that is low in tannin, caffeine-free and contains high levels of antioxidant.

There are 23 species of honeybush of which three are currently grown commercially. One of these species is mostly harvested in the wild, with the risk of damage to natural populations due to unsustainable harvesting. To establish a viable industry with growing potential, it is important to establish commercial plantations. . To meet this objective, the following studies are being undertaken at the ARC Infruitec-Nietvoorbij in Stellenbosch.

*Breeding and evaluation.* Three approaches are being used viz. evaluation of additionalspecies; intra-specific selection of superior genotypes and inter-specific breeding. Vegetatively propagated material of promising selections and hybrids has been established in different areas for further evaluation.

*Soil preparation:* Different soil preparation methods were investigated namely: soil preparation at depths of 0cm, 15cm, 40cm and 60 cm. One year old plants were harvested and their mass determined. The highest yield was obtained in the plots prepared to 15cm and the lowest yield in those without any soil preparation.

*Seasonal nutrient cycle in plants:* Two species were harvested five times during the year for sampling. Topgrowth and root dried and analysed for macro- and micronutrients. Nitrogen, potassium and phosphorus contents were highest during July, but dropped substantially in September (flowering time).

For more information visit: *www.arc.agric.za/home.asp?pid=4045*

*Keywords:* cultivation, Cyclopia species, honeybush

# EVALUATION OF SOIL MANAGEMENT PRACTICES FOR ORGANIC FRUIT PRODUCTION

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Present guidelines on organic fruit production are not scientifically based as few scientific results are available on organic fruit production in South Africa. This studies aim was to supply guidelines for sustainable organic fruit production.

Treatments consisted of two management practices applied to the tree row, namely chemical control or mulching. These were applied in combination with different treatments applied in the work row. The latter treatments included full surface mulching, cover crops during winter, weeds controlled chemically or slashed during summer, as well as these two management practices applied to weeds.Oats suppressed the winter growing weeds significantly, with wild radish remaining the dominant winter growing weed species in treatments with cover crops during winter. Rye remained the dominant winter growing weed where no cover crop was sown. In the treatments with no cover crop in winter and slashing the weeds during summer caused *Paspalum* to become the dominant summer growing weed. The annual weed species as a group remained dominant in the treatment where cover crop was sown.

No winter cover crop and weed slashing during summer, combined with mulch in the tree row, tended to be the most favorable to tree growth. The highest yield was obtained from trees with chemical control in the tree row and weeds slashed in the work row. Nitrate, ammonium, carbon and total cations in the soil were higher in plots with mulch in the tree row than where chemical control was applied in the tree row.

*Keywords:* Apple, organic, weeds, yield

# INCREASING APPLE YIELDS WITH NUTRICAL 19™

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South African apple producers are facing increasing global competition and only 25% of producers are making a profit. Profitability will depend in part on increasing production and fruit quality.

NUTRICAL 19™, a calcium based foliar spray, was applied to apple orchards in the spring of 2005 and again in 2006 at a rate of 6 litre/ha. The first spray was one week after fruit-set (10mm fruit size) and the second, two weeks later (20mm fruit size). At this stage of development, cell division was still taking place and calcium was important for cell wall formation. The trial was laid out as a randomized block design with two treatments and 49 replicates across five cultivars.

When the data sets of both seasons were combined, an average increase in production of 7.610 t/ha (P = 0.01) for all cultivars was recorded. The Golden Delicious cultivar was particularly responsive and data from both seasons showed an average yield increase of 10.260 t/ha (P = 0.01).

Across seasons the NUTRICAL 19™ apples showed increases in fruit mass and an increase in the percentage of apples falling into the 'Optimum Class' in terms of firmness (P = 0.04), fruit colour (P = 0.01) and starch (P = 0.01). Microscopic analysis revealed that the cells were longer by an average of 57.78 µm (P = 0.01).

The value of the increased yield to the Golden Delicious grower would be of great assistance in ensuring that orchards remain profitable and sustainable.

*Keywords:* Yield, firmness, starch, colour, apples, NUTRICAL 19™

# THE INFLUENCE OF LIGHT INTENSITY, LIGHT QUALITY AND ROOT ZONE TEMPERATURE ON POTATO MINITUBER PRODUCTION

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In S-A the production of minitubers as starting material for seed potato production is achieved by transplanting *in vitro* plantlets to a hydroponic growth medium in the greenhouse. Production systems need to be re-evaluated in order to maximize yields as commercial growers start to prefer earlier generation seed. Light and temperature in the greenhouse can affect crop growth, assimilate partitioning, yield and tuber quality. The objectives were to investigate the effect of light intensity (LI), light quality (LQ) and root zone temperature on potato plant growth, tuberization, assimilate distribution and tuber dormancy. The study was carried out at Welgevallen Experimental Farm, University of Stellenbosch. To asses the effect of light intensity, plantlets were grown in a closed greenhouse with evaporative cooling system and different shade treatments (20%, 40% and 50% shade nets) were compared to an un-shaded control. A decrease in LI caused an increase in fresh and dry weight of the shoots but a reduction in the shoot dry weight percentage. Tuber number per plant was not affected but tuber dry weight percentage was reduced by all shade treatments. Tuber dormancy and sprout growth was not affected by LI during crop growth. Subsequently the influence of LQ was determined in a comparable study where shade net was substituted with plastic absorbing different parts of the light spectrum. LQ treatments consisted of plants receiving light deficient in red, blue or far-red light. The results indicated that filtering part of the red light resulted in plants with an increase in plant height, leaf dry weight, tuber weight and tuber number. The blue light filter resulted in an increase in plant height, specific leaf area and stolon dry weight but tuber number and tuber fresh weight was not affected. Decreasing the far-red portion of the light reaching the plants decreased the internode length and increased the leaf dry weight percentage, while fewer tubers were formed. In a third experiment the effect of root zone temperature on growth, assimilate partitioning and tuber yield was investigated by growing plantlets in coarse washed sand cooled by the circulation of cold water through glass spirals in the medium. A root zone temperature of less than $15^0$C resulted in plants with a reduced height, lower leaf-, stem- and stolon weights and reduced leaf areas. Total growth was reduced but assimilate partitioning was shifted to the tubers under the lower root zone temperature although the final tuber number was not significantly affected. The results indicated that conditions that will improve greenhouse production of minitubers will include high light intensities, a cool root zone and the selective filtering of red light.

*Keywords:* crop growth, light intensity, light quality, minituber, root zone temperature, yield

# SUSTAINABLE IMPACT OF CONSERVATION FARMING SYSTEMS ON WHEAT PRODUCTION IN THE SOUTHERN CAPE

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Extensive crop production in the southern Cape is characterised by mixed farming systems of winter cereals (wheat, barley, oats), oil seed (canola), legumes and livestock under rain-fed conditions (200 to 375mm/yr). The typical soils are shallow (<450mm) with low moisture retention and low organic matter content. Wheat is the most important winter cereal being produced (2% of RSA production). The average yield for the region is 1,3 t/ha. With the advent of minimum tillage practices, a number of growers changed from conventional wheat production to conservation farming systems. This process of change involved defined crop rotation (5 or 10 year) whereby legumes (lucern or medics) are incorporated in the rest phase of the cycle. Furthermore, crop residues (e.g. wheat straw) are spread as mulch material on the soil surface during the harvest process. Conventional cultivation methods were eliminated by the introduction of new technology in soil cultivation equipment. Economic data collected from the regional wheat study group together with a field survey analysis of production practices was used to determine the impact of farming strategies on the economic viability of conventional, reduced tillage and conservation farming systems. Application of conservation practices resulted in higher yields (+22%) and reductions in seed use (-12%), N fertiliser (-12%) and P fertiliser (-27%). In terms of economic performance, these farmers were consistently placed in the top-third group, i.e. cost ratio, interest-turnover ratio, return on assets, return on equity and net capital ratio.

*Keywords:* Conservation farming, crop economics, crop rotation, mixed farming, sustainable wheat production

**EFFECTS OF DROUGHT STRESS ON TWO SUNFLOWER (*Helianthus annuus*) HYBRIDS YIELD AND YIELD COMPONENTS IN DIFFERENT DENSITIES**

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This study was carried out to investigate effects of drought stress on two sunflower (*Helianthus annuus*) hybrids yield and yield components in different densities in the form of split factorial by randomized complete block design in three replications. It was implemented in Tabriz-Iran climate in research from of Tabriz Azad university in 2005.

Test treatments included two hybrids of record and azargol sunflower and four levels of drought stress including blank ,75%,50%,25% available moisture and three levels of density including 80,90 and 100 thousand bush per hectare. stress was exerted on the basis of different levels of available moisture and density in hectare with a constant row space of 60 cm. density exertion on rows was in space of 16.66,18.52 and 20.83 cm respectively.

Results of the study showed that exertion of drought stress leads to significant decline in height and diameter of stem and also diameter and dry weight of anthodium, dry weight of stem, leaf and also dry weight of biomas per hectare, number of seeds in anthodium, length, width and weight of seed and seed function per single bush and hectare, oil percentage , oil function per single bush and hectare. In addition, exert from 80 to 100 thousand bush resulted in significant differences in the weight of 100 seeds, seed function per single bush, bush function per hectare, oil percentage, oil function per single bush and hectare.

*Keywords:* Azargol, density, drought stress, record, sunflower

# EFFECT OF CULTIVAR AND PLANTING DENSITY ON COB LENGTH IN GREEN MAIZE PRODUCTION

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In this study existing theory that relates kernel number per ear (KNE) to intercepted photosynthetically active radiation per plant (IPARP) during the 30-day period around silking was applied to optimise planting density in green maize production in Limpopo Province for a selection of cultivars. Maximizing the number of cobs per unit area that met the minimum cob length requirements of the local green maize market was the aim when selecting the cultivar and optimising the planting density. Two field experiments in which water and nutrient availability were not limiting were conducted on a deep Hutton soil at Dzindi Irrigation Scheme near Thohoyandou. A split plot experiment involving four planting densities (main plot) and PAN 93 and SC 701 cultivars (split), planted in September, demonstrated close relationships between planting density, IPARP, KNE and cob length, enabling the identification of optimum planting density in green maize production for the specific planting date and cultivars used. A split plot experiment involving two planting densities (main plot) and four cultivars (PAN 93, SC 701, ETZ 200 and SNK 2147) (splits), planted in August, demonstrated the critical importance of cultivar selection in green maize production. SC 701 and ETZ 200 were the two cultivars that were best suited for the conditions.

*Keywords:* green maize, cob length, cultivar, planting density

## THE PANICLE-PEST COMPLEX OF SORGHUM IN SOUTH AFRICA

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The most important panicle pests of sorghum world wide are the sorghum midge (*Contarinia sorghicola*) (Diptera: Cecidomyidae) and bollworms (*Helicoverpa armigra*, *Heliothis virescens*) (Lepidoptera: Noctuidae). In South Africa the spotted maize beetle (*Astylus atromaculatus*) (Coleoptera: Melyridae) also forms part of the panicle-pest complex, while in West Africa and Asia, the head bugs (Hemiptera) are important. The sorghum midge, occurs in all sorghum production areas of South Africa and is especially important in the Limpopo Province, while African bollworm is a sporadic pest of sorghum. Until recently no information existed on the importance of head bugs on sorghum in South Africa. Recent research in South Africa showed that 40 herbivorous Hemiptera species occur on sorghum. The most abundant family was the Miridae followed by the Lygaeidae which made up 41 % and 17 % respectively of the total number of individuals. *Eurystylus bellevoyi*, *Campylomma* sp., *Creontiades pallidus*, *Nysius natalensis*, *Nezara viridula* and *Sthenaridea suturalis* were the most abundant species and also occurred widely in the sorghum production area. The general tendency was that nearly all species were present from the flowering stage onwards and that numbers declined when grain hardened. Infestation levels of these species were generally low compared to that in other parts of Africa but comparatively high infestation levels were observed in some areas. The economic injury level for *N*. *viridula* is 6.8 per panicle in the USA, if infestation commences at soft dough stage. In South Africa *N*. *viridula* was recorded only from the soft dough stage onwards and at a mean infestation level of 4.3 / 100 panicles, which is far below the economic injury level. No research has been done on the control for panicle-feeding Hemiptera in South Africa. Early and uniform planting over wide areas is the most widely accepted method of reducing sorghum midge damage. The economic threshold level for insecticides for bollworm control on sorghum is when infestation levels reach two larvae per panicle during the milk stage. Damage caused by the panicle-feeding head bugs results in an increase in the incidence of seeds with discoloured germ and therefore contributes significantly to reduction in grain quality.

*Keywords:* African bollworm, economic injury level, *Eurystylus bellevoyi*, spotted maize, sorghum, sorghum midge

# SOIL MORPHOLOGY AS SIGNATURE OF SOIL WATER REGIME FOR SELECTED PROFILES IN THE CATHEDRAL PEAK VI CATCHMENT

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Soil morphology provides a long-term record of soil water regime. This record can be used in catchment hydrological studies. While soil water regimes have long been studied in relation to agricultural practices, diversification into studies of soil water regimes in relation to catchment hydrology is still in its infancy. There is a relationship between soil morphology and soil water regime which can contribute towards understanding hillslope hydrological processes and thereby facilitate information transfer between catchments. Hydrological monitoring in the Cathedral Peak VI catchment was done with neutron probes, spread over the catchment. A detailed description of profiles at measuring sites was made. The dominant soil form is Inanda (humic A/red apedal B/unspecified material with signs of wetness). It was assumed that reduction would occur at saturation higher than 0.78 ($s > 0.78$). The soils in Cathedral Peak VI, however, never reached $s > 0.78$ in the four years studied. It was therefore decided to use the average degree of water saturation per diagnostic horizon group over the study period. The average (s) values were: humic A = 0.46, red apedal B = 0.43, and unspecified material with signs of wetness = 0.47. The results showed that the soils in this catchment are freely drained with very little restrictions at the bottom of the profile.

*Keywords:* water saturation, redox

# EXPLORATORY SURVEY OF SOIL FERTILITY STATUS AND NUTRIENT MANAGEMENT PRACTICES ON SELECTED SMALL-SCALE FARMERS' FIELDS IN NORTH WEST AND LIMPOPO PROVINCE, SOUTH AFRICA

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Increased and sustainable crop production is often hampered by soil nutritional problems and poor nutrient management practices particularly on small-scale farmers' fields. Hence, a reconnaissance survey by means of questionnaire and oral interviews was conducted with farmers accompanied by surface soil sampling from their fields for detailed assessment.
A total of 167 fields in 13 municipal districts in the North West and Limpopo Province were visited to collect information on farming practices and soil nutrient management practices. The fields included individual and community as well as restitution farmlands managed by 286 small-scale and emerging farmers. The survey results revealed variable soil and crop management practices including the use of kraal manures (cow, sheep and goat) by small-scale farmers. The use of poultry droppings and wood ash were also reported in a few areas while inorganic fertilizer use is limited. Results of soil nutrient analyses showed that 78% of the farmers' fields are low in organic carbon while approximately 24% of the fields are low in exchangeable K content. Similarly, 14% of the farmers' fields are low in soil test P while only 23% of the fields had medium to high soil nitrate N levels. It is postulated that the various fertilizer materials were applied at below experimentally determined rates, which could guarantee increased and sustainable crop production. Integrated crop and nutrients management practices, using available local resources at an experimentally determined and feasible rate is recommended for resource-poor farmers while increased inorganic fertilizer use by emerging farmers should be promoted to ensure increased crop yields and sustainable production.

*Keywords:* Survey, soil fertility, crop productivity, management practices

**DETERMINATION OF *Tylenchulus semipenetrans* BIOTYPE IN ZEBEDIELA, REPUBLIC OF SOUTH AFRICA**

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Commercially available nematode-resistant citrus rootstocks had not been successful in reducing the losses incurred by the citrus nematode (*Tylenchulus semipenetrans Cobb*) in citrus-producing regions of South Africa. In the country, breeding of citrus rootstocks is based on the assertion that the nematode is the mediterranean biotype as opposed to the poncirus biotype. The biotype of the citrus nematode from Zebediela Citrus Estate was determined using 2-year-old differential hosts, namely, grape (*Vitis vinifera*), carrizo citrange (*Citrus sinensis* x *Poncirus trifoliata*), rough lemon (*Citrus jambhiri*), olive (*Olea europaea*) and trifoliate orange (*Poncirus trifoliata*). The study was conducted under greenhouse conditions using a randomized complete block design with 10 replications. Host plants were inoculated with 10000 juveniles each. The results demonstrated that the citrus nematode had reproductive factors greater than one on grape, rough lemon, trifoliate orange and carrizo citrange, but lower than one on olive. Since *T. semipenetrans* biotype from Zebediela did not reproduce on olive, but reproduced on all other hosts including *P. trifoliata*, it appears that this is the poncirus biotype. This result needs to be confirmed by inclusion of isolates from all citrus-producing regions of South Africa to assist in the development of resistant rootstocks.

*Keywords:* Races, plant-parasitic nematodes, oranges, reproductive factors

# PREDICTIVE MAPPING: EXPLOITING TACIT KNOWLEDGE TO IMPROVE SOIL SURVEYING

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Our hypothesis is that tacit knowledge about the distribution of soils in the landscape can be exploited to a larger extent to improve soil surveys than was done in the past. Soil mapping relies on the principle of data interpolation between observations making it possible to construct a soil map in spite of an unknown degree of variation. Soil maps serve as basis for planning land use changes in agriculture and predicting the impact of changes in the environment and the ecology. An improved understanding of soil distribution in the landscape and soil surveys will improve the role that soil data plays in decision making. The need to harness the contribution of soil data for environmental issues is accentuated by the growing need to predict the impact of different soil types on hydrological-related issues such as pollution and the quantity and quality of water supplied to rivers. Soil survey data is expensive to collect. Improving the quality of soil surveys involves attaining an appropriate balance between the necessary detail and costs. Comprehensive understanding of the distribution of soils in the landscape is an expert system in which tacit knowledge has an important role – because of the complexity of the system. This knowledge is developed by understanding the local soil forming processes that are dictated by the interaction between the prevailing factors of soil formation. These predictable spatial relationships form the scientific backbone expressed in land type maps. Case studies describing the development of the soil survey technique include: the evaluation of a particular land type for a specific agricultural land use using a soilscape survey; extrapolation of detailed soil surveys and land type data for hydrological purposes; evaluation of a specific soilscape for agriculture. Application of terrain relationships, makes it possible to subdivide land types into more homogeneous soilscapes, and soilscapes into more homogeneous hillslopes. Hillslopes serve as vehicles for decision making in agriculture and in hydrology.

*Keywords:* Soil map

# EVALUATING PRE-HARVEST FOLIAR CALCIUM APPLICATIONS TO INCREASE FRUIT CALCIUM AND REDUCE BITTER PIT IN 'GOLDEN DELICIOUS' APPLES

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In all major apple producing countries, applications of foliar calcium (Ca) products to increase fruit Ca content and to reduce the incidence of bitter pit in apples are used. Calcium nitrate ($Ca(NO_3)_2$), Calcimax and Ca acetate were applied, commencing at three different developmental stages (early, mid and late) of fruit growth. Late $Ca(NO_3)_2$ (80 days after full bloom (dafb)) applications increased the Ca content of fruit at harvest more than early (six dafb) and mid (40 dafb) applications. There was a trend towards an increase in bitter pit from early to late applications of $Ca(NO_3)_2$ and Calcimax, confirming previous results obtained when applying $Ca(NO_3)_2$. However, the incidence of bitter pit was too low (less than seven percent) and no significant differences between treatments were found. Ca acetate applications did not show any trends in fruit Ca content or bitter pit incidence when applied during the three stages. Thus, products may differ in efficiency of Ca absorption and effectiveness in decreasing bitter pit in fruit when applied during different developmental stages.

*Keywords:* commercial application, developmental stage, mineral fruit analysis

# EVALUATION OF CRISPHEAD LETTUCE CULTIVARS (*Lactuca sativa* L.) IN A SOILLESS PRODUCTION SYSTEM

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Crisphead lettuce cultivars were evaluated in three different growing seasons (summer, autumn and winter) at the ARC-VOPI (25,59$^0$S ; 28,35$^0$E). Variability and changes in environmental conditions and production systems makes it difficult to recommend cultivars suitable for a specific growth season. Low yield and quality are the main concerns. The objective of the study was to evaluate the performance of selected crisphead lettuce cultivars for summer, autumn and winter production with regards to yield and quality. During summer, autumn and winter, 16, 12 and 13 crisphead lettuce cultivars were grown, respectively, using a gravel-film production system. The experiment was laid out as a randomized complete block design with five replicates. During harvest, 12 data plants from each cultivar were harvested for yield determination and five uniform heads were cut longitudinally for internal quality assessment. For each cultivar, compactness, uniformity, ribbing, tip-burn, disease tolerance, bolting tolerance and number of days to maturity were recorded. However, certain cultivars did not exhibit all of these parameters. Cultivars that showed increased yield, improved harvest and quality for summer production were Aviram, Sahara, Robinson and Duke, and for autumn production were Supreme plus, Duke, Leenus and Dual purpose, while for winter production were Annie, Duke, L306, Pentagonia RZ, Supreme plus, Winterheiven and Winter supreme. Results, thus, indicate that improved yield and quality can be obtained by selecting the correct cultivars for summer, autumn and winter production in a soilless medium.

*Keywords:* Crisphead lettuce, cultivars, growing season

# INITIAL RESULTS ON NEW PROPAGATION METHODOLOGY FOR AMADUMBE (*Colocasia esculenta*)

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Amadumbe (*Colocasia esculenta*) is a tuber crop used by some communities in South Africa as a staple food source. Although it has been cultivated for decades by villagers of Kwazulu-Natal, it can be considered as a relatively unknown vegetable crop in South Africa. The crop is propagated primarily by separation of offsets termed cormels from the primary corm. Availability of quality propagation material often limits cultivation of the crop. The ARC-VOPI succeeded with *in vitro* propagation of Amadumbe during 2006/7. Since the application of *in vitro* techniques by farmers (especially small scale farmers) is limited and the multiplication rate is relative low (1.7-2.5), alternative propagation methodologies were investigated. The effect of corm size, corm sections, apical dominance and temperature on shoot and root initiation were investigated in a controlled environment. The corms were cut into several vertical and horizontal sections, sterilized with 1% sodium hypochlorite and placed in plastic bags filled with vermiculite to maintain humidity. The bags with corm sections as well as whole corms (Control) were placed in an incubator ($25/30^0$C) while shoot and root development were monitored on a daily basis. Apical dominance was lifted with several of the treatments resulting in the development of lateral shoots. Shoots developed within 2-3 days, with root initiation within 3-5 days, depending on the treatment. Shoots from terminal buds tend to grow and root faster than those from lateral buds. The rooted shoots were transplanted to a 40% shade net structure to monitor growth and development and compared to standard (whole corms) and *in vitro* propagation methods.

*Keywords:* Amadumbe, propagation, apical dominance

# EFFECT OF FERTILIZER MIXTURE ON GROWTH AND FRUIT YIELD OF CUCUMIS MYRIOCARPUS

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Efficacy of ground wild cucumber (*Cucumis myriocarpus*) fruit in suppression of root-knot nematode (*Meloidegyne incognita*) is well documented. Currently, the test fruits are collected from the wild, and this unrealiable source cannot meet the quantities required for producing a commercial biopesticides. Initial attempts to propagate this plant by seed failed, suggesting some form of seed dormancy. Thus, the study was initiated to remove inhibitory germination chemicals (IGCs) and to evaluate separate response of *C. myriocarpus* to fertilizer. Treatments comprised 0, 2, 4, 6, 8 and 10 g 2: 3: 2 (22) + 0. 05% Zn fertilizer mixture under microplot conditions, which was equivalent to 0, 5, 10, 15, 20 and 25 kg/ha arranged in a randomized complete block design, with 5 replicates each. At harvest, 94 days after initiating treatments, fresh fruits, shoots and roots were sampled. Shoots, fruits and roots were separately oven-dried at 60$^{o}$C for four days and weight recorded. Dried shoot weight and stem diameter had a positive linear relationship, while dried fruit weight had a curvilinear relationship with applied fertilizer levels. Fertilizer accounted 91and 95% of the TTV in shoot weight, 90 and 92% in stem diameter and 84 and 91% of the TTV in fruit weight in Experiment 1 and Experiment 2, respectively. In conclusion, the N:K ratio appeared to play a role in the productivity of *C. myriocarpus*. At 1:1 N/K, high quantities of fertilizer mixture reduced fruit yield of the test plant. Thus, additional studies are needed to establish N:K ratios that will promote fruit yield in *C. myriocarpus*.

*Keywords: Cucumis myriocarpus, Meloidegyne incognita*, biopesticides, inhibitory germination chemicals (IGCs), microplot

# EFFECTS OF MECHANICAL AND CULTURAL WEED CONTROL METHODS ON WEED GROWTH AND SWEET POTATO (*Ipomoea batatas*) YIELD AND GROWTH

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Sweet potato is generally known for its ability to smother and suppress weeds; however, weed control is necessary in the first two months of growth before canopy closure. Field trials were conducted during 2006 and 2007 to evaluate the effect of mulches (plastic, grass straw, news papers and compost) and narrow row spacing on weeds and sweet potato growth and yield. Treatments used were plastic, news papers, compost, grass straw, narrow row spacing, untreated control and hand weeding. Visual ratings of weed control effectiveness and canopy closure were made throughout the growing season. At harvest, storage root yield (weight, size and number) were assessed. In both seasons, all the treatments obtained full canopy cover at 120 days after planting, compared to 145 days in the untreated control. Narrow row spacing plots obtained earlier full canopy cover in both seasons at 60 days after planting. All treatments successfully controlled most of the weed population when compared to the untreated control, except for the compost and grass straw plots. There were no significant differences in crop yield between the various treatments and the untreated control in 2006. In 2007, however, all treatments exceeded the control in terms of marketable storage roots and total yields of sweet potato. Based on the results, mulching (plastic and news papers) and narrow row spacing could be used to improve weed management in sweet potato, since they provided effective weed control and earlier canopy closure.

*Keywords:* Sweet potato, mechanical methods, cultural methods

# USING APSIM TO SIMULATE MAIZE RESPONSE TO N APPLICATIONS UNDER DRYLAND AT TWO LOCATIONS IN LIMPOPO PROVINCE

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The Australian Centre for International Agricultural Research (ACIAR) Review Panel recommended that a previous project be extended for a period of 15 months. The aim of this extension was to obtain local field data on maize response to small applications of fertilizer N for parameterisation and validation of the Agricultural Production Simulator (APSIM) model. The ARC was approached to conduct the appropriate field trials. A low and high crop potential site was selected at Ga-Mashahane (Bellingsgate) and Nebo (Leeuwkraal), respectively. A maize trial (ca. 22 200 plants $ha^{-1}$) was laid out at each of the localities with four N treatments (0, 10, 20 and 60 kg N $ha^{-1}$) using three replications. Basal P applications were done at planting with a split application of the 60 kg N $ha^{-1}$ treatment six weeks after planting. Mechanical weeding was done when necessary. Crop growth and phenology, as well as soil parameters, were measured, while climatic variables were obtained from nearby weather stations. All data generated were subjected to analysis of variance.

This paper reports on the performance of the APSIM model in simulating yields for varying N fertilizer applications at the two localities. The experimental season was characterised by poor distribution and amounts of rainfall, which were not conducive to normal maize growth and development. The paper further evaluates the reasons for various unexpected outcomes in terms of N-response and influence of soil characteristics under adverse climatic conditions.

*Keywords:* Nitrogen application, APSIM, crop modeling

# CONSUMER PREFERENCES IN PEAR SENSORY ATTRIBUTES AND APPEARANCE OF ELEVEN DIFFERENT PEAR GENOTYPES

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Consumer preference for appearance as well as overall flavour must be considered before new pear cultivars are released into the market. The relationship between the objective assessment of sensory attributes and characteristics of pear fruit and the corresponding consumer and sensory panel ratings was studied among 11 pear genotypes. These genotypes consisted of commercial cultivars as well as promising selections from the ARC Infruitec-Nietvoorbij pear breeding programme selected to cover the range of pear skin colours from yellow to full red. Pears were harvested at optimum firmness from 9 January to 12 February 2007 and stored at -0.5 ºC. Samples of each genotype were removed after approximately four, six and ten weeks storage on 12 March, 26 March and 23 April respectively and placed at 15 ºC for four days to induce ripening. Fruit maturity and quality parameters were measured. A trained panel assessed sensory attributes and consumer preference for appearance and overall flavour was recorded. In both analyses panel members received an unpeeled and peeled segment of each pear type. According to appearance, the consumers had the highest preference for lightly coloured blush pears with a red on green colour combination. The measured chroma value had a relatively strong correlation with consumer preference for appearance with brighter colours being preferred over dull colours. In general, peeled samples had a higher degree of liking than unpeeled, especially samples with astringency. The majority of consumers indicated that a soft and juicy pear with a sweet taste was their preference. Consistent with this, consumer preference for flavour showed a positive correlation with total soluble solids and a negative correlation with fruit acidity and astringency. However, fruit firmness, total soluble solids and acidity did not correlate significantly with the results of the trained panel. Differences in consumer preference between genotypes were consistent over the three assessment dates indicating that the genotypic differences may override the effect of fruit maturity.

*Keywords:* Pear, breeding, flavour, colour, consumer

# ASSESSMENT OF TEMPORAL CHANGES OF WETLAND SOILS CHARACTERISTICS AND QUALITIES ACCORDING TO LAND USE PARTTERNS WITH SPECIAL REFERENCE TO THE HIGHLANDS OF LESOTHO

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The aim of the study is to monitor, evaluate and forecast the temporal and spatial changes of wetlands under the current trend of climate change and to propose sustainable land use options.

The study maps the extent and spatial variation of wetlands using conventional methods; characterizes wetlands soils (including mineralogy of clay); analyses data through GIS, statistical approaches and climatic models; identifies the key soil indicators and a minimum data set for assessment of wetland variation; models the functioning of the ecosystem; and proposes the method for monitoring and forecasting the change of wetlands.

The expected results the study are a list of pedological criteria, a definition of minimum soil data sets for the assessment of the changes in the functioning of the wetland ecosystem, a proposition of a model fit by the minimum of data sets to forecast the potential changes due to climatic variations, and proposed options for sustainable use of the wetlands.

*Keywords:* Minimum soil data sets, clay minerology, key soil indicators

## COMPARISON OF TARO LANDRACES FOR STARCH CHARACTERISTICS IN RESPONSE TO GROWTH TEMPERATURE

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Taro [*Colocasia esculenta* (L.) Schott; *Amadumbe* (Zulu)] has a potential for alleviation of food insecurity. Recent developments indicated that taro also has a potential to compete with potato (*Solanum tuberosum*) as a processing crop to produce chips. Hence a field trial study is being undertaken to determine the effect of planting date and variety on taro quality for production of crisp chips. Starch and sugar concentrations are some of the factors determining the quality of chips. Starch quality is influenced by environmental conditions during crop growth and storage. The objective of this study was to investigate the effect of growth temperature on taro corm starch quantity and grain physical features for the purpose of characterising local varieties. Three local landraces (*Dumbe-dumbe*, *Mgingqeni* and *Pitshi*) and a Tanzanian landrace (*Tanzania*) grown under controlled environment conditions (22/12$^{o}$C, 27/17$^{o}$C and 33/23$^{o}$C) were examined for starch grain characteristics using electron microscopy. Starch content and reducing sugars were determined using a titration method. Alpha-amylase was determined to relate starch degradation with starch characteristics at different temperatures. For *Dumbe-dumbe,* starch content decreased with increase in temperature (40.6% at 22/12$^{o}$C to 29.9% at 33/23$^{o}$C), but reducing sugars increased with temperature (1.04% at 22/12$^{o}$C to 5.25% at 33/23$^{o}$C). *Tanzania* also showed an increase in reducing sugars as the temperature increased(0.47% at 22/12$^{o}$C to 5% at 33/23$^{o}$C). Starch grain shape, size and texture differed among varieties, and there was significant effect of growth temperature. Alpha-amylase determination is still in progress, but it is expected to change significantly in response to growth temperature. The relationship between µ-amylase activity (starch degradation) and starch quality will be discussed. The findings of this study will be used as a basis for further investigations into taro quality for making chips as influenced by planting date under field conditions.

*Keywords:* alpha-amylase, taro, landrace, starch, temperature

# INFLUENCE OF DRIP AND FURROW IRRIGATION METHODS IN BIOLOGICAL FARMING OF TOMATOES

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Effective micro-organisms (EM) have a potential in suppression of root-knot nematodes in tomato (*Lycorpersicon esculentum*) production. The efficacy of EM was studied on tomato production under furrow and drip irrigation methods in two experiments. The four treatments, drip-alone, drip-EM, furrow-alone and furrow-EM were arranged in a randomized complete block design, with 10 replicates. At harvest, 101 days after initiating the treatments, effective microbes, particularly under furrow irrigation, improved tomato fruit yield and fruit quality, dry shoot yield and suppressed the root-knot nematode (*Meloidogyne incognita*) numbers in both root and soil. Improvement in tomato productivity and total soluble solutes with EM treatment suggests that this technology may have the potential of serving as an integral part of biological farming.

*Keywords:* Drip irrigation

# INFLUENCE OF EFFECTIVE MICRO-ORGANISMS AND GROUND *Cucumis myriocarpus* FRUITS ON SUPPRESSION OF *Meloidogyne incognita* IN TOMATO

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The root-knot nematodes inflict serious losses in tomato production. The study was carried out to investigate the possible interactive effects of effective micro-organism (EM) and ground wild cucumber (*Cucumis myriocarpus*) fruits in suppressing *Meloidogyne incognita* numbers in tomato (*Lycopersicum esculentum*). Treatments were arranged in a split plot design, with five EM levels being assigned as main plots and seven *Cucumis* levels as subplots. Microbe treatment was applied once weekly through drip irrigation, whereas ground *C. myriocarpus* fruits were applied once at transplanting. The interaction effect was not significant for the number of nematodes present in roots and soil systems. Nematode numbers were exponentially reduced by *C. myriocarpus* and linearly by EM. Results of the study demonstrated that potent nematicidal properties from ground *C*. *myriocarpus* fruits are exclusively released through irrigation water instead of microbial degradation.

*Keywords:* nematode

# EFFECT OF VENTILATION ON THE MICROCLIMATE AND TRANSPIRATION OF A ROSE CROP IN A GREENHOUSE

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Ventilation plays an important role in determining the greenhouse microclimate, and ultimately the crop production, as it influences temperature, humidity, crop transpiration rate and $CO_2$ concentration. The effect of different natural ventilation regimes on the microclimate and transpiration of several cultivars of a well-watered rose canopy (*Rosa hybrida*) in Zimbabwe were investigated by measurement and modelling. Different vent configurations and openings were evaluated: (i) side and roof openings and (ii) roof openings only. Experiments were carried out with the ventilators in two different positions, expressed as a percentage of maximum opening (0% or completely closed and 100 % or maximum opening). The relevant climatic variables (air temperature and relative humidity and vapour pressure deficit), average canopy temperature, transpiration rate and intercepted radiation were continuously monitored and the ventilation rates measured by the tracer gas technique. In order to generalise on the effects of the different ventilation regimes on the microclimate and transpiration of the rose canopy, the Gembloux Dynamic Greenhouse Climate Model (GDGCM) was used to simulate air temperature and humidity, canopy temperature and the crop transpiration rate using climatological observations and the different ventilation rates resulting from the ventilation regimes as inputs. The study demonstrated that wind speed and vent opening and configuration govern greenhouse ventilation rate and the resulting inside air speed, which determines greenhouse microclimate and crop transpiration. The results indicated that side and roof ventilation induced a more homogeneous vertical and horizontal field for temperature and humidity, by providing a more intensive mixing of the inside air than for roof only ventilation. It was found that the canopy-to-air temperature difference was significantly different, being less negative under side and roof ventilation, while the transpiration rates were not significantly enhanced under side and roof ventilation. Calculated values of the crop water stress index were similar and relatively high for both regimes. The estimated values of the stomatal conductance of the canopy were slightly higher (about 5 -10 %) under roof only ventilation. Normalizing the stomatal conductance of the canopy by radiation revealed a strong stomatal response to the humidity conditions prevailing at the surface of the canopy. It appeared that side and roof ventilation increased significantly the aerodynamic conductance, but did not influence significantly water consumption when compared to roof ventilation, because of the negative feedback between canopy-to-air vapour pressure deficit and stomatal conductance.

*Keywords:* ventilation, microclimate, transpiration, greenhouse

# POTENTIAL USE OF HOT WATER AND MOLYBDENUM DIPS AS METHODS TO MITIGATE CHILLING INJURY IN CITRUS FRUITS WITH EMPHASIS ON LEMONS (CV. EUREKA)

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South African lemons (cv. Eureka) must be cold-sterilised before or during shipping to Japan in order to reduce infestation of certain insect pests in the export country. Cold-sterilisation of citrus fruits can result in chilling injury (CI), which generally occurs as sunken lesions and discolouration of the peel, which reduces marketability of fruits. The objective of this study was to investigate the abilities of hot water (HWD) and molybdenum (Mo) dips in enhancing physiological resistance of lemons fruits to chilling injury. Fruits were dipped into three concentrations of molybdenum (1, 5 and 10 µM Mo) for 30 min, two hot water temperatures (47 and 53$^{o}$C) for 2 min and all interactions of molybdenum and hot water. The fruits were stored at –0.5$^{o}$C and samples of 75 fruits per treatment were sampled at an interval of 0, 7, 14, 21 and 28 days for evaluation of fruit weight loss and CI. Sampled fruits were peeled, freeze dried and stored at –21$^{o}$C until further use. Ethanol soluble sugar were measured using HPLC and total antioxidants using the FRAP assay. Mo and HWD dip influenced ethanol soluble sugars and total antioxidants to reduce CI in lemon fruits (cv. Eureka).

*Keywords:* hot water, molybdenum, chilling injury, citrus fruits, soluble sugar, total antioxidants

# EFFECT OF AN ORGANIC PLANT FERTILIZER AND CUTTING POSITION, ON THE ESTABLISHMENT AND GROWTH OF ROOTED CUTTINGS OF CYCLOPIA SPECIES

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Honeybush tea, indigenous to the Fynbos biome, and known for its health properties, is increasingly cultivated for commercialization. Material for plant propagation and establishment requires research on methodology, and few publications are available. The main objective of this study was to evaluate the influence of an organic plant fertilizer (Nitrosol®) on the establishment and growth of rooted cuttings of two *Cyclopia* species (*Cyclopia genistoides* and *C. intermedia*) with two cutting positions (terminal and sub-terminal). Rooted cuttings of these two *Cyclopia* species originating from two cutting positions were treated with Nitrosol® fertilizer at two application rates (3.33 ml.l$^{-1}$ and 1.67 ml.l$^{-1}$). The cuttings were uniformly inoculated once with a symbiotic *Rhizobium* bacterium to enhance the formation of nodules. Nitrosol® at 3.33 ml.l$^{-1}$ significantly affected plant fresh and dry weight, root fresh and dry weight, number of shoots and nodules per plant compared to either 1.67 ml.l$^{-1}$ or the control. Similarly, Nitrosol® at an application rate of 1.67ml.l$^{-1}$ significantly improved the above growth parameters in comparison with the control. *C. genistoides* performed better in terms of plant fresh and dry weight, root fresh and dry weight, and number of shoot and nodules per plant compared to *C. intermedia*. The origin of the cutting position did not significantly affect the above mentioned parameters. Plant mineral analysis indicated that the levels of essential elements increased with an increase in the available amount of fertilizer in the growing medium. *C. genistoides* had higher levels of mineral elements than *C. intermedia* after establishment.

*Keywords:* Cyclopia, cuttings, organic fertiliser, Nitrosol®

# THE EFFECT OF WINTER TEMPERATURE ON EMERGENCE AND GROWTH OF SUGARCANE

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A field experiment was conducted at Mt Edgecombe to determine the effect of winter conditions on emergence, growth and development of 80 germplasm lines and three registered cultivars of sugarcane. A complete randomized block trial design with three replicates was used and plots were fully irrigated and adequately fertilized. Single bud sets 100mm in length and cut 1/3 above and 2/3 below the bud were precision planted at 100mm depth during May 2006. Thermal time to emergence ($^{O}$Cd, base 10), rate of shoot elongation (SER, mm/d) measured from the ground to the top visible dewlap, and phyllochron ($^{O}$Cd, base 10) were recorded on a daily bases.

Results indicated significant differences in genotypic ability to emerge under winter conditions; from 203 ±6 $^{O}$Cd to more than 800 ±70 $^{O}$Cd for those that did emerge.

The SER before and after the 14$^{th}$ leaf stage differed significantly. Differences were not consistent and some genotypes demonstrated a faster and others a slower SER before the 14$^{th}$ leaf when contrasted to SER after the 14$^{th}$ leaf stage.

Phyllochron did not relate to thermal time to emergence or SER before or after leaf 14. SER did correlate negatively and significantly with thermal time to emergence, which may indicate that metabolic conditions during early growth may impact on later growth performance.

The results reported could be useful when stalk elongation or phyllochron is used to quantify plant growth status for production management and variety improvement purposes.

*Keywords:* thermal time, phyllochron, shoot elongation, genotypes

# EFFECT OF SEQUENTIAL CROPPING OF COWPEA (*Vigna unguiculata*) AND MAIZE (*Zea mays*) ON YIELD AND SOIL PROPERTIES

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Field experiments aimed at determining alternative management of commercial N-fertilizers to increase maize yield without adverse effect on soil and the environment were carried out in 2005/2006 and 2006/2007 growing seasons at Potchefstroom and Taung in North West province. Treatments in each trial consisted of four cowpea cultivars (Pan 311, Bechuana white, TVU 1124 and CH 84), four cowpea planting densities (10 000,15 000,20 000 and 40 000) seed $ha^{-1}$ and maize in rotation or maize monoculture. Maize was used to determine the residual effects of the cowpea crop. Results indicated that cowpea yield increased as density increases at both localities, and there was significant difference among cultivars at $P<0.01$. TVU 1124 had higher yield of 2558.3 and 2018.8 kg $ha^{-1}$ at Potchefstroom and Taung, respectively in 2005/2006 seasons. The results showed that maize yield increased in sequential cropping system (cowpea/maize) compared to monocropping at both localities. Significant differences also existed between soil microbial activities between cowpea cultivars. Cowpea cultivar CH 84 gave a higher residual soil $N0_3^-$ N yield of 7.47 mg $kg^{-1}$ and residual $NH^+_4$ -Nof 1.75 mg $kg^{-1}$ at Taung compared to other cultivars andmaize monocropping,whilst cowpea cultivar Pan 311 gave the highest residual soil $N0_3^-$ N yield of 6.73 and residual $NH^+_{4\text{-}N}$ of 3.18 mg $kg^{-1}$ in Potchefstroom. These results further confirm the potential of cowpea to N contribution for subsequent crops.

*Keywords:* residual N-effect, sequential cropping, monocropping, plant density, cowpea, maize

# YOUNG GRAPEVINES PERFORMANCE FOLLOWING FIELD INOCULATION WITH ARBUSCULAR MYCORRHIZAL FUNGI

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Information on benefits by inoculating grapevines with arbuscular mycorrhizal (A) fungi under field conditions is in short supply, as opposed to that obtained from pot trial studies under controlled conditions. More field evaluations are needed, especially as commercial farm soils are normally adequately supplied with mineral nutrient elements such as high phosphorus concentrations as well as indigenous AM fungal species, which may have an effect on inoculation. The objective of this study was to assess the success of inoculating young grapevines with selected AM inoculums under field conditions and to quantify the benefits of this symbiosis.

The trial was carried out at two commercial vineyards on the farm Groenland near Stellenbosch . Vineyards containing Merlot vines on 101-14 Mgt and 110 Richter (110R) rootstocks were planted on a ridged soil late in December 1998. At the same time another vineyard, containing Merlot on 99 Richer (99R) was established on an unridged Fernwood soil. Five treatments were applied during planting. Three of the treatments CAM1, G1054 and CAM2 each involved inoculation with AM inoculums. The fourth treatment consisted of a fungicide soil drench, applied shortly after planting. The fifth treatment (control) received neither fungicides nor inoculum. Over a period of two growing seasons following treatments (1998/99, 1999/2000), the vines were subjected to measurements of vigour, leaf water potentials, leaf nutrient concentrations and xylem sap composition. Percentage root colonisation by AM fungi was also determined over both seasons. Root colonisation rates among the three rootstocks after the first season ranged from c. 40% to 85%, and increased after the second growing season to rates ranging from c. 70% to 90%. It was established that the rootstocks in the control treatments were also colonized, which confirmed the presence of infective indigenous AM fungi in these vineyard soils. These naturally occurring AM fungi were sufficiently abundant and sufficiently infective to affect the root colonisation rates of two of the three rootstocks that received AM treatments as there was no significantl difference from those in the controls after one season. After two seasons, no differences in colonisation rate were apparent. As a result, the responses of the grapevines to AM fungal treatments and to the fungicide application were generally inconsistent in terms of growth, leaf nutrient concentrations and xylem sap composition. Evidence was nevertheless obtained, as indicated by leaf water potential, suggesting that inoculation with AM inoculants at planting may result in less water stress than in the case of colonisation by the native soil AM population only.

*Keywords:* arbuscular mycorrhizal fungi, indigenous, leaf water potential, rootstocks, root colonisation, grapevines

# SURVEY OF ARBUSCULAR MYCORRIZAL FUNGI IN GRAPEVINE NURSERIES OF THE WESTERN CAPE

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Grapevines are highly reliant on arbuscular mycorrhizal (AM) fungi for their nutritional needs, normal growth and development. Pre-inoculation at nursery level seems particularly vital with regard to dormant plants prior to transplantation in the field. Basic information with regard to the mycorrhizal status of South African nursery soils however, is lacking.

In this study, various soils of Western Cape grapevine nurseries were surveyed for the presence of AM fungi. The survey was carried out over one growth season in 15 different nurseries representing nine different areas, including those of Wellington (4 nurseries), Malmesbury (3 nurseries), Paarl (2 nurseries), Rawsonville (1 nursery), Bonnievale (1 nursery), Montagu (1 nursery), Piketberg (1 nursery), Klawer (1 nursery) and Hermanus (1 nursery). One cultivar, Chenin blanc/R99, was selected for the survey. Plant root and soil samples were collected 10 to 12 weeks after plant during February/March 2006, and again towards the end of the growth season in June/July 2007, just prior to removal of the plants. Plants and soil samples obtained at both these sampling times were microbiologically and chemically analysed, using standard methods. Spore counts were made and percentage root colonisation was measured. Mycorrhizal fungi were identified using morphological criteria. Arbuscular mycorrhizal fungi identified belong to the genera *Glomus*, *Acaulospora*, *Gigaspora* and *Scutellospora*. The species *Glomus mosseae*, Glomus (?- stipulate as *Glomus* is already mentioned) spp., *Scutellospora calopspora*, and *Acaulospora* spp., were consistently found in all the nurseries. High P-concentration seemed to have had little effect on myccorhizal root colonization. On one farm the root colonisation rate was 84% despite a soil P-concentration of c. 226 mg/kg P. The spore numbers ranged between 150 and 1000 spores/100 g dry soil earlier in the season and between 200 and 1600 spores/100 g dry soil towards the end of the season. The pH did not seem to have influenced the spore numbers in a particular fashion, although a slightly higher pH tended to be associated with lower counts. With the exception of a few, all the nurseries had spore numbers lower than a 1000/100 g dry soil. Tentative evidence for an increased effect of organic material on spore production was also obtained.

*Keywords:* arbuscular mycorrhizal fungi, grapevines, indigenous, nurseries, root colonisation

# SOIL WATER BALANCE-BASED SIMULATION OF MAIZE GRAIN YIELD AT FIELD LEVEL UNDER RAIN FED CONDITIONS IN THE HARARE REGION OF ZIMBABWE

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The production of rain fed maize in semi-arid regions is often hampered by a lack of comprehensive and objective guidelines for selection of both the optimum sowing date of the crop and the appropriate variety. In an effort to quantify the influence of water shortages to maize production at field level, a simple soil water balance model BUDGET, with an integrated $K_y$ yield simulator was validated for the simulation of maize grain yield reduction due to water stress in the Harare region of Zimbabwe. A field experiment in Split-Plot design of 3 sowing dates by 3 varieties was carried out at the University of Zimbabwe's farm (17.4 °S, 31.1 °E) in Harare over 2 seasons (2005/2006 and 2006/2007). Root zone water content was measured using the neutron probe periodically over the growing season and weather parameters were recorded using an automated weather station at the site. The validation involved comparing simulated root zone water content with the measured values. Further validation was provided by comparing simulated grain yield with the observed for the same site as well as for 3 maize varieties grown at ART Farm (17.7 °S, 31.1 °E), a research farm in the same region over 3 seasons. Typical yields expected in normal (50% probability of exceedence) and wet (20% probability of exceedence) years for a 3 variety by 2 sowing dates simulation experiment under rain fed conditions were analysed for the Harare region. The model performance indicated by model efficiency, EF (0.55 and 0.84 respectively for root zone water content and grain yield validation) and root mean square error RMSE (9.1% and 6.6% for the root zone water content and grain yield validations respectively), was satisfactory. The simulated grain yield for a wet year in Harare showed that a delay of 3 weeks from first sowing date did not result in a significant yield decline for all varieties used. Grain yield of the 3 varieties used was significantly different, ranging between 8 ton $ha^{-1}$ for SC403 and 11 ton $ha^{-1}$ for SC719. In a normal year, both variety and a sowing date delay of 3 weeks affected grain yield significantly. Yield decrease due to a 3 week delay in sowing were between 1 ton $ha^{-1}$ for SC403 and 2 ton $ha^{-1}$ for SC635 and SC719. On the other hand, yield increased by 1 ton $ha^{-1}$ with increase in growing cycle from early to medium then late maturing varieties for the first sowing date.

*Keywords:* BUDGET model, FAO Ky- yield simulator, soil water balance, root zone water content

# EFFECTS OF SHEEP KRAAL MANURE APPLICATION RATES AND INTERCROPPING WITH MAIZE ON GROWTH AND YIELD OF A VEGETABLE AMARANTHUS ACCESSION IN CENTRAL EASTERN CAPE, SOUTH AFRICA

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Amaranthus is among the nutritious indigenous vegetables that are collected from veld notably in the Eastern Cape. Its soil fertility requirements, as sole or intercrop, are key for its domestication and production as a leafy vegetable, particularly where manure is used. A dry-land experiment was conducted to study the effects of intercropping with maize, using sheep kraal manure, on growth, nutrient uptake and yield of Amaranthus. The experiment was set up in a split plot design with the main-plots solely cropped by Amaranthus, maize-Amaranthus intercropping and sole cropped maize. The sub-plots had five sheep manure rates ranging from 0 to 10 tons $ha^{-1}$ and inorganic NPK fertilizer {2:3:4(30)+Zn} applied at 100 kg $ha^{-1}$ as a positive control. Growth and yield of sole and intercropped Amaranthus plants grown with manure improved compared to the unfertilized control and compared well to results from NPK fertilizer. At 30 days after transplanting (DAT), both sole and intercropped plants fertilized with ≥ 2.5 t $ha^{-1}$ manure had fresh and dry matter yield comparable to plants fertilized with NPK fertilizer. At 60 DAT, intercropped plants fertilized with all manure levels had a bigger fresh matter yield when compared to unfertilized control whereas for sole cropped plants only those grown with ≥ 2.5 t $ha^{-1}$ compared to NPK fertilizer. Uptake of N, P, K, Ca and Mg increased with an increase in manure application in both sole and intercropped plants. Whereas Amaranthus did not suffer from competition in intercropping, maize biomass and grain yield was severely reduced with the effects being evident after 60 DAT. The findings of this study are essential in the production of Amaranthus as a leafy vegetable especially when intercropped with maize.

*Keywords:* Amaranthus accession, dry matter yield, intercropping, nutrient uptake

# TOWARDS GERMPLASM MAINTENANCE OF THE COMMON WILD MELON OF SOUTH AFRICA

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Wild melon (*Citrullus lanatus*) is an indigenous crop of South Africa. Lack of research and development has led to the demise of the crop as a staple. In KwaZulu-Natal , two varieties of the crop are known: *ibhece* and *ikhabe*, which can be eaten raw or boiled. *Citrullus lanatus* was identified as a possibly drought-tolerant indigenous crop with potential for commercialisation. The objective of this study was to collect germplasm and study it for maintenance. Seeds of two landraces were collected from subsistence farms at Umbumbulu and Centane, in KwaZulu-Natal and the Eastern Cape, respectively. The KwaZulu-Natal seeds were light-brown, whereas the Eastern Cape seeds were very dark brown. The landraces were identified by the farmers who donated them as *ibhece* (KwaZulu-Natal) and *umxoxozi* (Eastern Cape), respectively. Seeds were grown in a field trial to determine yield and seed performance. There were significant ($P < 0.05$) differences between landraces with respect to yield. *Ikhabe* produced fewer, but larger, fruits per plant compared with *umxoxozi*. Seed colour was associated with seed germination capacity, dormancy and longevity. Fresh seeds of u*mxoxozi* were significantly ($P < 0.01$) more dormant than those of *ikhabe,* but the dormancy was lost during after-ripening (25 $^{o}$C). Cold storage (10 $^{o}$C) delayed loss of dormancy in *umxoxozi*; however, seed vigour of both landraces was maintained better in cold storage compared with warm storage. This study provided an understanding of the yield potential and seed storability of an underutilised indigenous crop. The present data will be used for germplasm maintenance in the future.

*Keywords: Citrullus lanatus*, germplasm maintenance, indigenous

# SWEET POTATO FERTILIZATION TRIAL IN HAZYVIEW

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Sweet potato is a good food source, especially orange-fleshed sweet potato which is rich in pro-vitamin A. The cultivation and consumption of vitamin A rich sweet potato can thus address vitamin A deficiencies in the diets of people living in rural communities. Proper fertilization management is essential when growing sweet potato in order to improve storage root yield and quality. Recently, ARC-VOPI released several new sweet potato cultivars specifically for production in rural areas. There is a need to research the fertilization needs of sweet potato so that an economical fertilization regime can be given to resource poor farmers. A sweet potato fertilization trial was carried out at Hazyview in the Mpumalanga province in March 2007. The two rates of chemical fertilization (50% and 100%) used were based on soil analysis. A control treatment with no fertilization was also included in the trial. The aim of the trial was to evaluate the impact of fertilization on sweet potato storage root yield and quality. Quality assessments included nutritional analysis of storage roots. Results indicated that increased fertilization (100%) had a beneficial effect on the marketable yield (39.7 and 36.7 t/ha at 50%, 58.4 and 45.3 t/ha at 100%) of the orange fleshed cultivars. However, an increase in fertilization rate (100%) did not lead to increased marketable yield (35.8 and 62.8 t/ha at 50%, 33.7 and 46.5 t/ha at 100%) and total carotene content of the white fleshed cultivars. The results also showed improved total soluble solids (TSS) content with increased fertilization. Cultivars reacted differently to fertilizer treatments as indicated by marketable yield, carotene and TSS content results obtained. Applying fertilizers has, thus shown to have a beneficial effect on the sweet potato storage root yield and quality.

*Keywords:* Sweet potatoes, fertilization, yield, quality

# CURRENT KNOWLEDGE ON THE KALAHARI DESERT TRUFFLES (*Kalaharituber pfeilii* Trappe)

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Like other mushrooms, the fruiting bodies of the Kalahari Desert Truffles (*Kalaharituber pfeilii* Trappe) are very nutritious with relatively high amounts of proteins, carbohydrates, minerals, fibre and vitamins. In Botswana, the Basarwa (Bushmen) collect and consume the truffles annually between May and July. Although there has been some research on various aspects of this indigenous crop, there are still numerous gaps that need to be considered in order to understand their ecology, phenotype, physiology and utilization, among other research areas. The objectives of this paper are to reveal the importance of truffles to the Basarwa community and to the international society at large, collate research work that has been carried out on them, indicate the significance of the research findings and to identify areas that require further research and development. Most work has focuses mainly on determining the symbionts that form mycorrhizal association with the truffles, but with varied and inconclusive findings. Thus to date, it has not been possible to cultivate truffles for commercial purposes. The generic placing of the truffles and identification has been done successfully. The nutritional studies have placed the truffles as prominent providers of nutrition, but more work needs to be done to determine antioxidant activity of the extract. There is a lot more that we do not know about truffles than we currently know.

*Keywords:* Kalahari desert truffles, mycorrhizae, nutrition, indigenous, fruiting bodies

**UNDERSTANDING THE CHEMICAL BASIS OF FEMALE PREFERENCE- LARVAL PERFORMANCE RELATIONSHIPS OF LEPIDOPTERAN PEST OF SUNFLOWER**

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The preference-performance hypothesis predicts that females should preferentially choose hosts that their offspring would perform better on. We tested this hypothesis for the sunflower moth, *Homoeosoma electellum* (Hulst) on 17 sunflower germplasm lines. Lines were selected to give a range covering those used in breeding for yield and those used for insect or disease resistance. In binary choice tests, using a standard control line, females showed a range of preference responses to the lines. Performance on the 17 lines, tested by infesting each of the heads with 20 neonate larvae and recording the number of pupae obtained and their individual weights, also varied among lines. Female preference and larval performance (both in term of percentage of larvae reaching the pupal stage and pupal weight) were positively correlated; indicating that females tended to chose plants on which larvae performed better. The means of the preference and performance measures for each of the 17 lines were also positively correlated, indicating that females preferred lines on which larvae performed better.

*Keywords:* Preference-performance hypothesis

## EVALUATION OF THE SUITABILITY OF PINE BARK – GOAT MANURE CO-COMPOSTS AS GROWING MEDIA FOR SEEDLINGS

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The potential of composts made from pine bark (PB) or pine bark co-composted with goat manure (PBGM) as growing media was evaluated in the laboratory and under greenhouse conditions with and without fertilization using a slow release fertilizer. Composts were analysed for chemical and physical parameter in the laboratory and thereafter tested for their suitability as growing media in a greenhouse. Various crops were raised in the composts using different levels of a slow release Horticorte 7:1:2 (22) fertilizer. Germination was determined two weeks after sowing. Crops were allowed to grow for 4 weeks after which both the shoot biomass was harvested and shoot fresh and dry weights determined. Shoot were analysed for N, P and K contents. The water holding capacities of both PB and PBGM were higher than the minimum required but their air filled porosities were below optimum. Chemically though PBGM was found to nutritionally superior to PB. There were no significant differences in germination due to medium type for cabbage, amaranthus and beetroot but in the case of maize significant differences in germination were observed where PBGM reduced germination by up to 15 % relative to PB. There were significant differences in the growth of crop transplants between the two growing media. In both substrates increasing nutrient availability by adding controlled-release fertilizer had similar positive effects on growth of transplants. Significant fertilizer -growing medium interactions was observed in both wet and dry matter yields of shoots for all the crops. Results revealed that pine bark-goat manure co-composts supported good seedling growth and could thus be good substitutes for pine bark alone as a growing medium. Results also showed that despite the superior nutritional value of these alternative growing media, nutrient supplementation may still be necessary where seedlings are kept in the nursery for extended periods due to nutrient exhaustion through plant uptake and leaching. Use of a slow release fertilizer is highly encouraged as this can lower both nutrient losses through leaching and production costs.

*Keywords:* pine bark goat manure composts, pine bark composts, growing medium, slow release fertilizer

# LITTER FALL PATTERN, YIELD AND QUALITY OF LEAF BIOMASS FROM THREE SUB-TROPICAL FRUIT TREES IN NELSPRUIT, MPUMALANGA PROVINCE

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Leaf litter and its quality play a major role in predicting decomposition rate and the nutrient release pattern in an agricultural ecosystem. Sub-tropical fruit crops produce a reasonable amount of leaf litter every year that has a potential to be used in soil fertility management, especially under small-scale farming. There is no much work done on the dynamic of these materials from sub-tropical fruit crops. A study was conducted in Nelspruit to assess leaf fall pattern, yield and chemical quality of litter biomass of three sub-tropical fruit trees viz avocado (*Persea americana*), litchi (*Litchi chinensis*)and mango (*Mangifera indica*). A 3.5 x 4 x 3 m nylon mesh litter trap was constructed around five individual mature trees of each species and falling leaves were collected every month for a year (2006). The leaves were analyzed for N, C, lignin and polyphenol. In all the trees, leaf fall was low during September to November but increased steadily to a peak in February-March after which it declined to its lowest levels (June and August). The peak period of litter fall coincided with the rainy season. The total annual litter biomass collected was 1.73, 0.66 and 0.34 t/ha for litchi, mango and avocado respectively. There were significant ($P<0.05$) differences in the quality of the leaves from the tree species. The results indicated that litter biomass from avocado is best followed by litchi. The total nitrogen content was 1.18, 1.08 and 0.90% for avocado, litchi and mango respectively. The respective associated C: N ratios were 41:1, 46:1 and 50:1. The lignin content was highest in litchi (39.4%), followed by avocado (37.2%) and mango (24.8%) while polyphenol was in the order mango (5.9%), litchi (2.7%) and avocado (1.93%). The results show that leaf litter produced by the three trees had different qualities and that these would affect its management when used to manage soil fertility. The effects of litter quality on nutrient release and uptake by plants need further investigation.

*Keywords:* Leaf biomass, chemical quality, sub-tropical fruit trees, soil fertility management

# MYCOTOXIN LEVELS IN SUBSISTENCE FARMING SYSTEMS IN SOUTH AFRICA

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*Fusarium verticillioides* and *Aspergillus flavus* are toxin-producing fungi associated with maize and groundnut. *Fusarium verticillioides* produces fumonisins in maize, and *Aspergillus flavus* produces aflatoxins in maize and groundnut kernels, both toxins are responsible for carcinogenesis in humans and animals. Contamination of maize and groundnut with mycotoxins is often most severe in rural areas where subsistence farmers are unaware of their existence and follow agricultural practices that might contribute to their production. A questionnaire was, therefore, compiled to investigate agricultural decisions in rural areas that may influence mycotoxin contamination of crops. During 2005/06 and 2006/07, maize and groundnut samples were collected in KwaZulu-Natal (KZN), Eastern Cape, Mpumalanga, and Limpopo provinces. Mycotoxin levels were quantified using the ELISA technique, and the incidence of *Fusarium* spp. in maize grain was determined by plating out on Fusarium selective Rose Bengal-Glycerine-Urea (RbGU) medium. Fumonisin producing *Fusarium* spp. were quantified using the quantitative PCR (TaqMan) technique. The incidence of *A*. *flavus* and *A*. *parasiticus* was determined by plating out groundnut kernels on Potato Dextrose Agar (PDA). Fumonisin contamination levels in maize samples ranged from 0 - 21.8 parts per million (ppm) and aflatoxin levels ranged from 0 - 49 parts per billion (ppb), depending on the region where samples were collected. Aflatoxin levels in groundnut ranged from 0 - 161 ppb. *Fusarium verticillioides* was the most common *Fusarium* sp. in maize followed by *F*. *subglutinans* and *F*. *proliferatum*, respectively. Regression analyses showed a positive correlation between fumonisin concentration and fumonisin producing *Fusarium* species when determined by quantitative PCR (TaqMan) ($r^2$=0.553558, $r^2$=0.8658, $r^2$=0.677326). Regression analyses further showed a highly significant positive correlation between *A*. *flavus* and aflatoxin contamination ($r^2$=0.10235, *P*-value= 0.0302). Samples from northern KZN contained levels of mycotoxins that were far in excess of the maximum levels set by the Food and Drug Administration (FDA) in the USA. In South Africa there are currently no regulations with regard to the maximum allowable levels of fumonisin in human food. The high incidence of mycotoxin contamination of human food in subsistence farming systems indicates the need for awareness programmes and further research.

*Keywords:* fumonisin, aflatoxin, questionnaire, RbGU medium, TaqMan

# BIO-ACIDULATION OF ROCK PHOSPHATES FOR CHEAPER SOIL AMELIORATES

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Phosphorus is a major contributor to plant growth and development, this in spite of the fact that its concentration in the soil is only approximately 0.05ppm. Technology at smallholder level is limited in terms of attainment of P-bearing local fertilisers. The high cost of P and P-bearing fertilisers calls for alternative forms of P additions to the soils. Therefore the use of locally available phosphate rock (PR) sources becomes necessary. However, the main obstacle for the direct application of phosphorus rocks (PRs) to soils is the failure of PRs to release P into the soil solution in quantities sufficient to support plant growth. Where treatment is required, the treatment costs of the PR highly outweigh the benefits of the fertiliser.

Most of South Africa's phosphate rock deposits are igneous in nature, making it difficult to use them in direct applications without P acidulation. Elsewhere in the continent it has been reported that P-bearing fertilisers could be produced from phosphate rock deposits. The cheap technologies they use, however, might not be applicable in SA since the nature of SA's deposits differ from those reported in other studies in the continent. This paper deliberates options to cost effectively develop fertilisers from igneous phosphate rock deposits for small scale applications. It looks at the chemistry, mineralogy, microbiology as well as the physical soil environment for rapid mobilisation of phosphorus from apatite and related sources. This work forms part of a PhD study at the Department of Soil Science and Plant Nutrition of the University of Pretoria.

*Keywords:* Rock phosphate, acidulation, P mobilisation, soil fertility, mineralogy

# THE NITROGEN FERTILIZATION REQUIREMENT OF CANOLA

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Canola, which is a relative new crop to South Africa, is considered a valuable source of protein by the animal feed industry. It is mainly grown in the winter rainfall area but can also be grown on the highveld in winter under irrigation. Fertilisation is the largest single cost-of-production-item of dryland canola production. This will most likely also be the case for irrigated canola. Scientifically determined fertilisation guidelines for irrigated canola in South Africa are currently not available and those from elsewhere are not consistent. The aim of this project was to determine guidelines for N fertilisation for canola. Field trials were planted during the winters of 2004, 2005 and 2006 on a sandy textured soil at Vaalharts and a loamy soil at Potchefstroom. Six fertilization rates varying from zero to 300 kg N $ha^{-1}$ were applied on two cultivars. Calculated optimum yields and associated N rates showed a high degree of variability among seasons and localities. However, a general N fertilisation rate for irrigated canola of 204 kg $ha^{-1}$ is appropriate when a target yield is not taken into account. The delta yield procedure, however, where the soil N supply and yield potential are both taken into account, shows potential as a reliable method for determining the N fertilisation rate and can be calculated with the equation: N fertilisation rate in kg $ha^{-1}$ = $D^{0.687}$ where D = delta yield measured in kg $ha^{-1}$.

*Keywords:* Canola, delta yield nitrogen fertilization

# CORRELATION BETWEEN YIELD AND YIELD COMPONENTS IN MAIZE - LABLAB INTERCROPPING SYSTEM

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Maize is the major staple food in the Limpopo Province of South and hence dominates the smallholder farming system of the province. Intercropping of maize is a common practice among small-holder farmers in the province. Maize is the most important crop in the intercropping system, while the legume is used manly as leafy vegetable. Field experiments were planted at Dalmada and Syferkuil during 2001/02 and 2002/03 growing seasons. The treatments examined were five different density of lablab, namely: 0; 2; 4; 6; 8 plants per meter length (2001/02) and an additional 10 plants per meter length in 2002/03 and two planting dates for lablab. The experimental design was a randomized completely block design in factorial with three replications. Maize cultivar used was SNK 2147 and lablab was Rongai. The lablab was planted between 90-cm inter row spacing of maize and thus creating a distance of 45 cm between the maize and the lablab. Five rows were planted at both locations in 2001/02 growing season at both locations and 8 rows in the 2002/03 growing season. Three centre rows were harvested in the 2001/02 growing season at both locations and 5 rows in 2003/03 growing season. Row length was 4 m in the 2001/02 growing season at both locations, whereas in the 2002/03 the length was 4.5m. Maize grain yield was harvested from 9.45m$^2$ and 22.5 m$^2$ during 2001/02 and 2002/03 growing season respectively for yield and yield components determination. The differences in harvested area was due to differences in plot size during the growing seasons Seed yield samples of maize were taken from the middle rows of each plot, leaving one row on each side as a border row. Yield components of both crops were recorded when the seed yield data was collected. Maize yield components were recorded as cob number and weight, rows cob$^{-1}$, kernels cob$^{-1}$, cob weight and weight of 100 seed. Cobs were oven dried at 65$^0$C to reduce grain moisture percent to 12%. The objectives of the study were to determine the influence of lablab planting dates and densities on maize yield components and the relationship between maize yield components and grain yield. There was a general trend of decreasing maize grain yields as lablab density increase. Maize yield components results followed a similar pattern as that of maize grain yield at both locations and growing seasons. Simultaneously planting of lablab and maize at high density significantly reduces maize grain yield and yield components. Maize intercropped with 2 and 4 plants of lablab per meter produce equal or higher maize grain yield and yield components than sole maize and other intercrops when planted simultaneously. In conclusion it is recommended that small-holder farmers in Limpopo province intercropped maize with 2 and 4 plants of lablab per meter length.

*Keywords:* Maize, Lablab, yield, planting density, planting date

# ASSESSMENT OF LEAF NITROGEN ACCUMULATION THROUGH CHLOROPHYLL CONTENT AS INFLUENCED BY LAB-LAB PLANTING DATES AND DENSITIES

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It was discovered that leaf nitrogen concentrations greatly influence both the development of maize canopies and their photosynthesis. Dryland field experiments were conducted at two locations in the Limpopo Province of South Africa. The names of the two locations were University of Limpopo experimental farm at Syferkuil and a smallholder farmer's field at Dalmada near Polokwane during 2001/02 and 2002/03 growing seasons. Maize cultivar used was SNK 2147 and lablab was Rongai. The lablab seeds were inoculated with a commercial *Bradyrhizobium* strain just before planting. The experiments were established as a randomized completely block design in factorial with three replications at each location. The factors studied were planting date and planting densities of lablab as follows; six different densities of lablab, namely; 0,2,4,6,8 and 10 plants per meter length. These lablab planting densities were either planted simultaneously with maize or 28 days after planting maize. The lablab was planted between 90-cm inter row spacing of maize and thus creating a distance of 45 cm between the maize and the lablab. Five rows were planted at both locations in 2001/02 growing season at both locations and 8 rows in the 2002/03 growing season. Three centre rows were harvested in the 2001/02 growing season at both locations and 5 rows in 2003/03 growing season. Row length was 4 m in the 2001/02 growing season at both locations, whereas in the 2002/03 the length was 4.5 m. Spacing between lablab and maize was 0.45 m. Chlorophyll content was measured for young leaves of the same plants in a plot every week using a hand chlorophyll meter (SPAD). After harvest the stover was used to determine nitrogen yield. In the later-planted intercrops, the pattern of chlorophyll production was similar to the simultaneously planted system at both locations. Chlorophyll content generally peaked at 96 DAP at Dalmada while it remained unchanged at Syferkuil over the period. Senescence of lower leaves occurred at 103 and 117 DAP for first and second leaves respectively. A general increase of maize leaf nitrogen was observed in maize intercropped with 2 and 4 plants of lablab per meter length as compare to sole maize. Maize leaf chlorophyll content was high when lablab was planted 28 days after planting maize than the simultaneously planting. It is therefore recommended that small-holder farmers in Limpopo province to plant maize with 2 or 4 plants of lablab per meter length or the lablab can be planted 28 days after planting maize.

*Keywords:* Leaf nitrogen, chlorophyll , Maize, Lablab

# PHYSIOLOGICAL AND MORPHOLOGICAL CONSEQUENCES OF DROUGHT ON TWELVE UPLAND COTTON GENOTYPES IN SOUTH AFRICA

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Growth and moisture deficits can depress cotton (*Gossypium hirsutum* L) development both morphologically and physiologically. A physiological understanding of plants' responses to drought has often been sought on the pretext that this understanding will assist plant breeders to develop higher yielding varieties for water-scarce environments. However, despite extensive scientific reviews on plants' response to drought there are few documented examples where a physiological understanding of drought has identified traits that limit yield under drought and where these have been used. Selection for an optimal plant height has been important, particularly in temperate crops to avoid lodging and to maximise harvest index (HI) in favourable environments. Despite substantial physiological research into understanding the response of plants to drought, and genetic variation in these responses, there are few examples where this research has led to improved varieties. Most cotton physiological drought stress research has been conducted in growth chambers, or greenhouses, arid region.

Trials were planted in split plot design with three replications where irrigation was assigned to main plot and varieties were subplots in 2005/2006 growing season. The two irrigation types were normal irrigation; the trials were irrigated like normal cotton production, and rainfed, a dry land production was simulated. Under rainfed the plants were irrigated at crucial stage of development for example after sowing and for four weeks after emergence to enhance development. Twelve cotton varieties grouped in to three groups namely very tolerant to drought (Marico; Nebo 108; Tugela; Alpha), sensitive to drought (RB50 x DC 2417;Tetra; Sicala; DPAc90 X S42) and very sensitive to drought (Molopo; 1208 x SJS; OR19; and OR3) were evaluated and screened for drought at the Agricultural Research Council-Institute for Industrial Crops (ARC-IIC), at Kroondal. The objective of the study was to determine the influence of drought on physiology and morphology parameters such as biomass accumulation, soil moisture contents, boll formation, plant height, yield and yield components. Irrigation type significantly influenced biomass accumulation, soil moisture contents, boll formation, plant height, cotton lint yield and yield components. Yield components included number of bolls/per plot, weight of five bolls, number of seed/five bolls, 100 seed weight/five bolls, cotton lint yield/five bolls and cotton fibre/five bolls. Varieties also significantly influenced all the parameters. Six varieties namely Tugela, Alpha for tolerant, Tetra Sicala for sensitive and Molopo and OR19 for very sensitive gave the highest yields.

*Keywords:* Soil moisture, physiological, morphological

# CARBON LOSS FROM BRACHYSTEGIA SPICIFORMIS LEAF LITTER IN THE SANDY SOILS OF SOUTHERN MOZAMBIQUE

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Leaves of *Brachystegia spiciformis* represent a substantial fraction of the total aboveground litter in bush fallow fields with sandy soils in southern Mozambique where annual rainfall exceeds 600 mm. This species is one of the most important in the Miombo Woodlands, the natural vegetation of the region. Proper knowledge on the decomposition of its litter residues is therefore crucial for understanding processes responsible for natural build-up of fertility in agricultural soils abandoned to bush fallow during shifting cultivation. This study investigated the effects of soil water content and soil temperature on loss of organic carbon from decomposing leaves in 1 mm mesh size litterbags. The litterbags were buried 50 mm deep in bare and fallow fields of sites covering a climatic transect with annual rainfall from < 400 mm to > 1000 mm. Two patterns of carbon loss were observed, one in coastal and wetter agro ecosystems (rainfall > 600 mm) and the other in inland and drier agro ecosystems (rainfall < 600 mm). In the coastal and wetter agro ecosystem carbon loss was faster than in the inland and drier ones, where it was more sensitive to rainfall pulses. Similarly, carbon loss was faster in fallow fields than in bare ones. During summer, bare fields reached soil temperatures higher than the estimated upper boundary favourable for carbon loss from decomposing leaf litter at all sites. A simple dynamic decomposition model described the carbon fraction remaining in the litterbags. Coefficients of determination ($R^2$) for the individual experimental units varied between 0.79 and 0.97. The general model for all sites and fields explained 86% of the total variation when using measured soil temperature and soil water content as modifiers of the decomposition rate. Root mean square error and systematic bias were 9.7 and 0.5% of initial carbon, respectively. Decomposition was more strongly affected by soil water content than by soil temperature and explained 75% of the total variation. Thus, rainfall is main the driver of carbon loss from leaf litter in these agro ecosystems.

*Keywords:* Litter decomposition, bush fallow, agroecosystems

## HERBICIDE RESISTANCE IN IRRIGATION AREAS OF DOUGLAS: A REALITY!

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Wheat and barley are the main small grains that are produced in the irrigation areas of Douglas. This area contributes approximately 15% of all small grain production in South Africa. Recently producers have noticed that *Avena fatua* (wild oat) is not controlled as well as in the previous seasons. The wild oat spread was also much wider than was previously observed. Wild oats interfere with the crops, competing for water, light and nutrients and interfere to a large extent with the harvesting process. Seedling samples were obtained from a producer in Douglas and brought to the ARC-Small Grain Institute to be screened for herbicide resistance. Greenhouse trials were conducted where the seedlings were screened with the five herbicides most commonly used in the irrigation areas, namely Gramoxone®, Roundup® (pre-seeding herbicides), Topik®, Ravenger® and Achieve® (post-emergence herbicides). All herbicides were applied at 0.5x, 1.0x, 2.0x and 3.0x the recommended rate with their recommended adjuvants. The treated seedlings were evaluated 14 days after treatment. The results obtained from these experiments clearly indicated that Gramoxone® and Roundup® gave 100% control of this biotype of wild oats at the recommended rate. Achieve® showed the best percentage control of all post-emergence herbicides used, but still had mediocre control. Topik® and Ravenger® showed dangerously low percentages of control, with Ravenger® showing percentages control as low as 43.8% at 3x the recommended rate. Multiple resistance was also observed in this biotype of wild oats. The results clearly indicate that herbicide resistance is such a reality in the irrigation areas that other control methods must be found for effective control of wild oat.

*Keywords: Avena fatua*, multiple herbicide resistance, irrigation areas, wild oats

# INFLUENCE OF CONSERVATION MANAGEMENT PRACTICES ON SOIL QUALITY ATTRIBUTES IN EASTERN CAPE PROVINCE OF SOUTH AFRICA

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Soil quality is essential for plant growth and terrestrial ecosystem management. The declining soil quality in 's arable lands is attributed to low organic matter content caused by intensive tillage, short or no fallow and absence of crop rotations. Conservation management practices have the capacity to sustain and enhance soil quality. However, there is lack of consistent information on impact of various conservation management practices on soil properties in the semi arid Eastern Cape Province. We evaluated the short term effects of management systems on soil properties and identified soil parameters with high sensitivity to alternative management. Our field study compared four conservation management options with conventional practice (CT) on alfisol and mainly of alluvial type (Oaklef form) at University of Fort Hare. Conservation management options were (i) conventional tillage with stover retention (CTSR); (ii) conventional tillage, stover retention and intercrop (CTSRI); (iii) no-till (NT); and (iv) no-till with intercrop (NTI). A randomized complete block with 4 replicates was used. Eighteen soil parameters were determined for each management options at 0-5 and 5-20 cm depth increments. SOC, EC, Ext. N and P and SR, PMC, MBC and N parameters varied significantly among treatments. Principal component analysis (PCA) was used to identify parameters that were highly influential (PCs) and accounted for large portion of the total variation in the data set. PCs bassociated with soil chemical and biological parameters were more powerful in explaining a higher proportion of the variance in the data set than physical parameters. Hierarchical cluster analysis (HCA) was used to verify similarity among alternatively managed systems. The CT managed treatment was clearly separated from maize stover retained CT plots and the NT plots with or without intercrop. Soil biological (PMC, MBN, MBC and MBC/N) and chemical (ext. N and P) parameters were the most sensitive parameters to treatment differences. Parameters associated with microbiological activities and the nutrients closely linked to plant growth were useful soil quality indicators in this study.

*Keywords:* Soil quality, principal component analysis, hierarchical cluster analysis

**EFFECT OF pH ON GROWTH YIELD AND QUALITY OF BUCHU (*Agathosma betulina*)**

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Buchu (*Agathosma betulina*) is one of the traditional medicinal plants originating from the Cape Floral Kingdom of the Western Cape province of South Africa and the essential oil derived from the leaves is exported in large volumes. Due to high demand, under supply and price for Buchu oil, growers have started to commercialize it, but little is known with regard to growth conditions required for maximum production. The main objective of this study was to determine the optimum pH range needed for the production of high yielding, early maturing Buchu with acceptable essential oil quality. *A. betulina* seedlings were grown in 9.5 litre pots filled with a 1:1 mixture of graded, washed sand and coco peat in a greenhouse where the temperature was controlled using a wet wall and a fan system to keep maximum temperatures below 25°C. Five pH treatments (3-3.99, 4-4.99, 5-5.99, 6-6.99 and 7-7.99) replicated eight times were applied using a hydroponic system. The electrical conductivity (EC) was kept between 0.8 and 1.1 $mS.cm^{-1}$ in all the nutrient solutions used. The pH was adjusted to the required levels after every mixing and monitored throughout the trial. Plant height was measured every second week to determine the growth, while fresh and drymass production was determined after a growth period of seven months. Over time, plant height displayed an exponential increase for all the treatments, but plants from the pH treatment 7-7.99 grew at a much slower rate compared to other treatments. The pH treatment 4-4.99 showed the highest rate of biomass accumulation, though not significantly different from that of pH treatments 5-5.99, 6-6.99 and 3-3.99. High levels of diosphenol and absence of any measurable amounts of *cis*- and *trans*-acetylthio-p-menthan-3-one isomers were obtained from oil analyses from all the pH treatments indicating that it originates from pure *A. betulina* and it represents the disophenol chemotype with low levels of menthome and isomenthome. Pulegone levels were also high, and there were no significant differences due to the pH treatments with regard to the quality of the oil.

*Keywords:* EC, pH, yields , essential oil, growth, quality

# TOMATO PRODUCTION IN A STRIP-TILL SYSTEM

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The growth and yield of tomatoes in a strip-till in grass (ST) were compared with tomatoes grown in a conventional tilled field (CT). The experiment was conducted at the Experimental Farm of Natuurboedery Research Center, Waterpoort station during 2007 season. The treatments initially received the same amount of fertilizer and water. However, due to poor vegetative growth during the early growth stage in the ST treatment, the latter was split into three subplots, corresponding to extra-nitrogen application at a rate of 0 $kg.ha^{-1}$ (ST1), 50 $kg.ha^{-1}$ (ST2) and 100 $kg.ha^{-1}$ (ST3). The competition of the grasses with the tomato plants for nutrients and water resulted in decreased leaf area index, plant height and vegetative dry matter production. The advantages of strip tillage were reflected in a reduction in production cost related to land preparation, while water runoff and soil compactions were decreased resulting in increased water infiltration. High total fungal biomass, total bacterial biomass, flagellates and amoeba counts, which are indicators of a healthy soil, were recorded in the ST treatments. Comparisons among ST treatments showed that yield and growth of tomatoes increased with elevated nitrogen application. There was no significant difference between the yield of ST3 and CT plots suggesting that high nitrogen applications are needed to ensure good growth and yield under a strip-till tomato production system.

*Keywords:* Strip-tillage, conventional tillage, nitrogen, yield, growth

# INTERACTION BETWEEN THE GRAIN YIELDS OF RICE CULTIVARS WITH ENVIRONMENT (SOIL) IN FOUR AGRO-ECOLOGICAL ZONES IN NIGERIA

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An investigation was conducted in five AEZs in Nigeria to evaluate the effect of soil on the grain yield (GYs) of four new rice cultivars. Ten on-farm experiments were conducted in four AEZs (Northern Guinea Savanna, Derived savanna, Southern Guinea savanna and savanna). The experimental design was a randomized complete block, and the treatments were AEZ and rice cultivars: WAB 189, P-38, P-31, P-18, Ofada (farmers' local cultivar) and ITA 150 (control). Data were collected on the soil physico-chemical characteristics, the grain and biomass yields. All trials were farmer managed. Data were subjected to analysis of variance (ANOVA) and the step-wise multiple regression analysis (SMRA). A scatter gram graphical method was used to determine the most stable rice cultivars across the AEZ. ANOVA results showed that the GY of rice cultivars ranged between 2.55-3.44t/ha, which is not significantly different. The SMRA showed that only pH, available P and clay were significantly related to the GY of rice with $R^2$ of 36, 53, and 63% respectively. The slopes of regression equations of the rice cultivars were of the order Ofada > WAB1>ITA150>P31>P38>P18. Thus, the most stable rice cultivar is Ofada, which has been widely adopted by farmers in all AEZs. In addition, results showed that proper management of soil pH and available P and clay would significantly improve the GYs of these rice cultivars.

*Keywords:* Rice, Environment, Soil, Yield, Agroecological-zone, on-farm

# EFFECTS OF AIR TEMPERATURE AND SOIL ON SAUVIGNON BLANC WINE STYLE IN THE STELLENBOSCH WINE PRODUCING AREA

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A nine-year study was carried out in two non-irrigated, commercial Sauvignon blanc vineyards, each at a different locality. Though reasonably close to one another (9 km), one vineyard was located at a greater altitude. In each of these vineyards, two plots were selected, one characterized by appreciably greater evidence of sub-soil wetness than the other. Meteorological data obtained from the two vineyards showed that the maximum temperature for February was 1.9 ºC lower at the high altitude (413 m) site than at the lower (148 m) vineyard. Night temperatures were also lower at the higher site. Grapes in the higher, cooler vineyard were generally harvested two weeks later than those in the lower, warmer vineyard. At the cooler locality ripening was affected by soil form. Grapevines on the drier soil were harvested approximately one week earlier than those on the wetter soil. Also at the higher, cooler locality, wine from the wetter soil exhibited a prominent fresh vegetative character (grass, green pepper, eucalyptus, mint), whereas that from the drier soil was characterized by cooked vegetative (green beans, asparagus, olive, artichoke), and by fruity aromas. In the lower, warmer vineyard, however, soil differences did not significantly affect wine style. Further, in contrast to the vegetative and cooked vegetative characteristics of the wines from the higher, cooler vineyard, tropical fruit character dominated in wines from both the dry and the moist soils in the lower, warmer vineyard. These findings suggest that the style of Sauvignon blanc wines from Stellenbosch is not only affected by air temperature (probably varying as a function of altitude), but also by differences in soil characteristics, notably with regard to wetness.

*Keywords:* altitude, maximum temperature, Sauvignon blanc, soil moisture, Stellenbosch, wine style

# INCREASED IRRIGATION WATER USE EFFICIENCY OF SUGARCANE BY MEANS OF A PLANT RESIDUE LAYER

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The South African sugar industry is under increasing pressure to demonstrate that limited water resources are being used efficiently. One way of achieving this is through the retention of a layer of plant residues from the previous crop to reduce wasteful evaporation from the soil surface. It is against this backdrop that a research project, partially funded by the Water Research Commission, was initiated at Komatipoort. The main objective of the project was to investigate the effect of a residue layer on crop growth, water use and cane yield of fully irrigated sugar cane. Stalk population, stalk height, radiation interception and crop water use were recorded regularly. Results from both the plant and ratoon crop have shown that although initial growth was affected negatively, final cane yield was not significantly reduced. The presence of a plant residue layer had a marked effect on seasonal crop water use and was reduced by an average of 26% (305 mm) and 21% (214 mm) for the plant and ratoon crops respectively. Results will be used to improve crop models to account for the effect of residue layers on crop growth and water use, and to formulate best irrigation management practices for profitable and sustainable sugarcane production.

*Keywords:* Sugar cane, crop water use, residue layer, irrigation water use efficiency

# AN INVESTIGATION OF THE FACTORS AFFECTING KERNEL DISCOLOURATION IN SOUTH AFRICAN MACADAMIAS

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Kernel discolouration is a disorder affecting macadamias, in which a dark superficial stain discolours part of the cream to white coloured nut. The stain may occur as a thin ring on the equator of the kernel or may affect the entire basal half of the kernel. The colour ranges from pale brown to almost black in the most severe cases. Kernels exhibiting this disorder must be separated and reworked (chipped into smaller pieces), resulting in a loss of value of the product.

The disorder is more prevalent in the “Beaumont” cultivar than in others and also appears to vary between production areas. In 2005 samples collected for maturity testing in Mpumalanga indicated that there is also considerable variation in discolouration between farms in a relatively small area, stretching from Barberton through Nelspruit and white River to Hazyview. This was confirmed in a dedicated study carried out in 2006. Examination of the samples collected in these two years also showed that the disorder tends to decline in severity as the season progresses, and this has been confirmed in 2007.

Past work on other subtropical crops has indicated that there are relationships between fruit quality, weather (particularly rainfall) and nutrition. An analysis of rainfall data for the 2005 and 2006 sampling periods seems to indicate a relationship between rainfall and discolouration, with drier periods in a year of below average rainfall coinciding with peaks in the occurrence of discolouration. This is particularly noticeable in dryland orchards. A comprehensive analysis of mineral content in collected samples is underway but there are early indications that affected kernels show elevated levels of iron and manganese, and that these minerals selectively accumulate in the thin layer of cells affected by the stain.

It is proposed that either the accumulated minerals are contributing to the stain or that they are indicative of a mineral imbalance which leads to cellular damage and resulting polyphenol oxidation during the drying of the nuts. Since this phenomenon is exacerbated by dry conditions, growers are advised to ensure that trees receive sufficient water in the critical period approaching harvest, particularly in drier years.

*Keywords:* Macadamia, kernel, quality, discolouration

# THE CONNECTION BETWEEN SEA SURFACE TEMPERATURES AND SEASONAL STREAM FLOW IN THE UPPER OLIFANTS CATCHMENT, SOUTH AFRICA

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Rainfall over southern Africa during the summer months is affected by sea surface temperatures (SSTs) so one expects seasonal stream flow also to be related to the El Nino/Southern Oscillation phenomenon, as they are linked via the hydrological cycle. A Climate Predictability Tool was used to evaluate the relationship between sea surface temperatures and stream flow at different lead-times in the upper Olifants catchment in Mpumalanga, South Africa. Four stream flow stations were selected from each of the sub-catchments, namely the Groot Olifants on the eastern side and the Wilger on the western side of the catchment. Canonical Correlation Analyses (CCA) were used to make a three-month stream flow forecast for the summer rainfall season October-November-December (OND) and January-February-March (JFM). Monthly global-scale SSTs were used to evaluate the connection between SSTs and stream flow. Pearson's correlation values greater than 0.50 were selected. Possible connection between stream flow and SSTs from the Equatorial Atlantic, Southern Atlantic, Tropical Indian and Equatorial Pacific Oceans were investigated. The Equatorial Atlantic, Southern Atlantic, Tropical Indian Oceans showed a similar connection to stream flow but the Equatorial Pacific Ocean showed a different connection. The connection between SSTs and stream flow could be useful in improving stream flow forecasts for better water resource management in South Africa.

*Keywords:* Stream flow, Oceanic Domains

# THE EROSION CONTROL POTENTIAL OF PALM GEOTEXTILES: A RAINFALL SIMULATOR STUDY

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Mats manufactured from palm leaves have recently been reported to be highly effective and economically viable erosion control products. The objective of this study was to test these findings by determining the extent of differences in erosion-related variables between a range of soils and mine tailings, both bare and covered with palm mats via rainfall simulation. Measured erosion parameters included runoff (RO), sediment load in the runoff (SL), percentage of stable aggregates (SA), final infiltration rate (Fi) and interrill erodibility (Ki). A total of 20 representative South African soils and 10 mine dam tailings have been investigated. The soils varied considerably with respect to their textural, chemical and mineralogical properties according to soil taxonomy, annual precipitation and geological substrate. Tailing sample selection was based on the dominant minerals mined.

Erosion parameters varied greatly within, but to a much lesser extent between, the two materials. The following results were obtained: RO ($cm^{-3}$) 2525-3796; SL (g) 75-575; Fi (mm $h^{-1}$) 0-14.6; SA(%) 6.7-22.8 and Ki (kg $m^{-4}$ $s^{-1}$) 2.6-17.9. Once the samples were covered with palm mats, SL was almost halved. The palm mats did not improve water infiltration, however, and even led to slightly (~7%) increased runoff volumes. These results clearly document the beneficial effect palm geotextiles have on erosion control, effectively conserving soil on sloping lands, regardless if the soil is agricultural land or engineered slopes such as road embankments or dam walls. The extent of reduction was independent of the sediment load of the uncovered soils and both the least and most highly erodible soils had their sediment load reduced by a similar percentage.

Investigations formed part of the EU-funded BORASSUS project (INCO-CT-2005-510745) that is one of very few research initiatives in the field of agriculture using existing – and unutilized – plant material. An additional benefit is potential job creation, in this case the manufacture of erosion control mats.

*Keywords:* soil erodibility, erosion control, rainfall simulator

# CURRENT STATUS OF HERBICIDE RESISTANCE IN SOUTH AFRICA

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Herbicide resistance is a worldwide phenomenon and currently herbicide resistance has been recorded in 183 plant species. Herbicide resistance in South Africa was first recorded in 1986 in *Avena fatua* to diclofop methyl. Since then reports of herbicide resistance in weeds in South Africa has increased dramatically. It is important to know as much as possible about the problem to be able to manage it effectively. The objective of this study is to verify the incidence and extent of herbicide resistance in South Africa. The incidence of herbicide resistance is monitored in two ways. Firstly, suspected herbicide resistant weed populations are tested at the Agronomy Department of the University of Stellenbosch under controlled conditions. Secondly, questionnaires are distributed to personnel of agrochemical companies in the winter rainfall region in which cases of suspected herbicide resistance are reported. These results are stored in separate databases. The numbers of weed samples sent in for testing has increased from 8 in 1999 when the service commenced to 194 in 2003. In 2004, 2005 and 2006 the numbers of samples tested has decreased to 87, 67 and 59 respectively, due to various factors including on-farm tests performed by agrochemical companies and acceptance of the fact that herbicide resistance is present on farms. Currently resistance to seven different herbicide modes of action groups has been confirmed in 13 weed species. The most important herbicide resistant species in annual crops are *Lolium* spp. and *Avena* spp. The most problematical weeds in perennial crops are *Lolium* spp. and *Conyza bonariensis*. New species in which herbicide resistance has been observed but not yet confirmed are *Cotula* spp., *Emex australis*, *Senecio cardaminifolius*(?) and *Chenopodium carinatum*. The winter rainfall region of South Africa is the region with the highest incidence of herbicide resistance but isolated cases in the summer rainfall areas have also been reported. Comparison of the results of questionnaires distributed to the same agrochemical personnel in 2003 and 2005 showed that the number of suspected herbicide resistant cases increased by 20%. Information about herbicide resistance and the management thereof should be widely disseminated among all role players in agriculture. The problem can only be effectively managed if sufficient knowledge about it exists.

*Keywords:* Herbicide resistance

# A COMPARISON OF REGRESSION-BASED AND WEIGHTED-AVERAGE APPROACHES FOR THE RECONSTRUCTION OF DAILY MAXIMUM TEMPERATURES

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Continuous time series data of weather variables, including temperature, has become a necessary ingredient in many environmental models. However, gaps and errors in data often occur in the operational environment. In order to obtain a continuous time series, errors need to be corrected and missing values need to be estimated. In this study a number of regression-based and weighted-average methods for interpolating daily maximum temperatures over South Africa are investigated. Reconstructing daily temperature data over South Africa is complicated by the fact that the region has a highly variable station density and also includes areas of complex topography. The methods investigated include: simple extrapolation with elevation from the nearest climate station; pure spatial interpolation based on inverse distances and Gaussian weights; and a number of methods based on multiple linear regression and weighted-averaging. Different approaches to calculated lapse rates are also investigated and a method for station selection based on station density is formulated. All methods were tested by performing a cross-validation over a ten-year period. Methods were verified over the South African domain but also over various sub-domains including regions of low station density, high station density and regions with steep topography. It is found that methods based on multiple-linear regression in combination with a calculation of lapse rates outperform those based on pure spatial interpolating and methods based on fixed lapse rates. The method used to select the number of stations to be included in a specific method seems to be a crucial factor in the accuracy of the reconstructed temperature.

*Keywords:* Daily maximum temperature, spatial interpolation, lapse rates, station density

# AN INVESTIGATION INTO THE EFFECTS ON MEDICINAL PLANTS WHEN GROWN IN A HYDROPONIC SYSTEM

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Medicinal plants are declining rapidly in numbers as many of the plants are highly utilised for their medicinal properties. Due to the fact that they are used as medicine, many of them face extinction if the plants are not cultivated to sustainably produce these plants for the market. However, when plants are removed from their natural environment, changes in their chemical composition can be observed. These changes can be enhanced if a plant is cultivated by factors such as irrigation and fertilisation. Very few medicinal plants are cultivated on a commercial scale, and how these plants react to fertilisers and irrigation is not known. This pilot study was initiated to determine what the effects on selected medicinal plants would be when grown in a hydroponic system. Hydroponics is a system that could be used to grow medicinal plants in a shorter period of time to a suitable size that can be harvested. It is, however, important to ensure that the medicinal properties of the plants are not compromised by growing them in such an unnatural system. Four medicinal plant species were used in the trial, namely: *Ruta graveolens*, *Artemisia afra*, *Leonotis leonurus* and *Rumex crispus*. The general growth, leaf analysis and chemical composition of the plants were evaluated to determine if this is a viable system to produce medicinal plants. Thin Layer Chromatography (TLC) and High Performance Liquid Chromatography (HPLC) were used to analyse the chemical composition of the plants. Four different extracts, that covers the polarity spectrum, were prepared for each plant in order to extract as many as possible compounds from the plant, as there is no information on the type of compounds that are being dealt with. This paper will give an indication to the applicability of hydroponics in their production of medicinal plants.

*Keywords:* Medicinal plants, hydroponics, cultivation, chemical analysis

# VEGETATIVE PROPAGATION OF *Pappea capensis* (JACKET PLUM) TREE BY AIR LAYERING

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Jacket plum (*Pappea capensis L.*) produces seeds rich in edible oil (74%), which is used in making soap and is a potential source of bio-diesel fuel. Jacket plum trees are mainly propagated by seeds but seedling growth is extremely slow and rooting by cuttings is difficult. The objective was to determine rooting potential of air layering on Jacket plum. The study was conducted in spring 2006 and autumn 2007 at the Experimental Farm of University of Pretoria. Eighty branches of about 20 mm thick were selected and ring barked (2 cm wide). Air layering was executed on dioecious trees in four quadrants (north, south, east and west) with a hormone treatment. Treatments were replicated five times in each quadrant. Rooting %, root length, root number and dry root mass data were collected. Rooting success of air layers from treatments during spring was significantly higher than those during autumn. The spring treatment also resulted in improved root length and number of roots. Air layers of the fruit-bearing tree rooted more than those of non-fruit bearing tree during spring. However, in autumn, on flowering trees, rooting performance was poorer. It appears that tree direction and hormone application do not play a major role in the response to air layering of the Jacket plum.

*Keywords:* season, dioecious, rooting hormone, bio-diesel fuel

# AN ANALYSIS OF HISTORIC VARIETY TRIAL DATA: INVESTIGATING TRIAL YIELD ADJUSTMENTS AND ESTIMATES FOR THE SOUTH AFRICAN SUGARCANE INDUSTRY

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The Variety Evaluation Project at SASRI involves conducting variety trials throughout the S.A. sugarcane industry. Trials are conducted on SASRI research farms and on growers' commercial fields. A general trend is that trial yields consistently exaggerate commercial yields obtained by growers under the same conditions. The objective of this study was to evaluate the possibility of using correction factors and plot yield estimates to obtain realistic and applicable trial data that corresponds to commercial standards. Historic variety trial and commercial yield data was analysed to evaluate the extent of the yield exaggeration between trial and commercial yields. The analysis was used to investigate the possibility of trial yield adjustments to acceptable commercial levels. Additionally, long-term variety trial data was used to investigate the possibility of using semi-destructive sampling to estimate trial plot yields.

Trial yields consistently followed the same trends as commercial yields since initiation of the project. However, trial yields were on average 30 t/ha more than commercial yields. A correction factor of 0.7 was identified as being appropriate enough to adjust trial yields to that of commercial levels across the sugarcane industry on average. A suitable correction factor was subsequently calculated for each mill area in the industry (ranged from 0.65 to 0.8). An analysis of on-station and off-station trials indicated that off-station trials followed commercial trends more accurately than trials conducted on SASRI farms. A higher level of management on research farms and the lower variability within trial plots was identified as possible reasons for the deviations from commercial trends. It was shown from further analysis that trial plot end-effects may not be the major contributor to the exaggerated yields, as per common perception. A positive significant relationship ($r^2$ =0.65) was found between actual plot yields vs. estimated yields from semi-destructive sampling. Estimated yields also followed the same trends as commercial yields. Applying a correction factor to estimated yields adjusted the data to correspond with commercial levels. This indicated that semi-destructive sampling, followed by the application of a correction factor may be an acceptable way of determining realistic trial yields when actual trial harvesting cannot be done.

Results from this study will assist in the optimisation of variety recommendations to growers in the S.A. sugarcane industry. The data generated will assist with future decisions regarding trial locations, plot sizes and trial measurements in the Variety Evaluation Project.

*Keywords:* commercial yields, trial yields, variety evaluation

# SHIKIMATE ANALYSIS: A RAPID METHOD FOR SCREENING OF PLANTS FOR GLYPHOSATE RESISTANCE

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Glyphosate causes symptoms of injury to plants that may be confused with those attributed to various other factors, e.g., nutrient deficiency, low temperature, and other herbicides. The time taken for plants to show symptoms of glyphosate injury is similar for both the acetohydroxyacid (AHAS) and acetyl CoA carboxylase (ACCase) type herbicides, and the symptoms of chlorosis, which the latter two types cause, can easily be confused with those of glyphosate damage. The mechanism of action of glyphosate involves inhibition of the biosynthesis of three essential amino acids which causes accumulation of shikimate in plants. The concentration of shikimate was determined by HPLC using a Luna $NH_2$ column (250 x 4.6mm, 5µm particle size) according to a modified method of previously published procedures. Rapid accumulation of shikimate was detected in glyphosate-sensitive soybean and maize plants, whilst no accumulation was seen in glyphosate-resistant varieties of the two crops. Therefore, accumulation of shikimate in a glyphosate-treated crop or weed indicates that the plant is sensitive to glyphosate, and vice versa. This assay procedure can complement visual assessments that form the basis of investigations on suspected glyphosate injury to nontarget plants, as well as to aid the identification of glyphosate-resistance in weed populations.

*Keywords:* Weed resistance, crop injury, glyphosate damage

# A TRASHY TOPIC: SUGARCANE TRASH DECOMPOSITION

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More than 80 % of South Africa's sugarcane is burnt before harvest, to enable efficient harvesting and faster regrowth. It is agronomically desirable, however, to remove the dead leaves ('trash') from the stalk and leave them as mulch on the soil surface. This conserves soil moisture and suppresses weeds. This trash layer can, however, become restrictive where a high trash yield hinders subsequent field operations. A trial was therefore set up to test various amendments for their effects on accelerating trash breakdown. A randomized complete block design was set up on a vertisol at Mount Edgecombe, Durban, in November 2006. Twelve plastic crates were set into each plot. Crates had slotted sides and bases, and the tops were open to the atmosphere. A known mass of trash (including dead leaves and green tops) was placed into each crate on a layer of topsoil. Treatments included two controls (T1 bare soil - disregarded here, and T2 trash without amendments); T3 trash + calmasil lime; T4 trash + Effective Microbes (EM); T5 trash + Condensed Molasses Solids (CMS) + urea; T6 trash + CMS, +urea + EM; T7 trash + CMS + EM; T8 trash + urea; T10 trash + *Aspergillus* sp. fungus; and T11 trash + 'Bio-Earth' trash-specific inoculum and urea. The product planned for T9 was taken off the market shortly before the trial began. The trial was replicated for summer and winter starting dates. Each month during the year, one crate was removed from each plot in the trial. Trash depth and dry mass was measured in these crates; monthly data were analysed using ANOVA and Holm-Sidak multiple comparison tests. For the summer trial, treatment and sampling month both showed significant differences ($F = 0.006$ and $< 0.001$, respectively) in trash mass. As expected, all crates had less trash mass towards the end of the sampling period, than at the beginning. Of the 260 g of trash originally added to each crate, an average of 141 g (54 %) remained after 9 months. T6 tended to have least trash remaining at each sampling, though it was only significantly lower than T4. Trash depth also decreased significantly in the latter months ($F < 0.001$). Although based on fewer months' worth of data, the winter results showed significant differences in trash mass according to treatment and sampling month ($F = 0.009$ and $< 0.001$, respectively). Again, mass decreased over time, with T8 tending to have lower trash mass than the other treatments. Depth also decreased over time. In part, results are as expected – trash mass and depth decreased over time as the matter decomposed. T6 and T8 look promising as agents of decomposition, while T4 has fared poorly so far. Sugarcane growers might therefore consider using T6 to enhance *in situ* trash decomposition, provided that this option is economically justified by being an appropriate source of nutrients for their soils.

*Keywords:* sugarcane, trash, decomposition

# IMMATURE LEAF COLOUR CAN BE USED TO STREAMLINE THE BREEDING OF BLUSHED PEARS

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The ARC Infruitec-Nietvoorbij has a programme in place for the breeding of new blushed pears. This is a costly process, as thousands of seedlings must be maintained for about eight years until they bear fruit. However, many of these seedlings will produce fruit of undesirable colour, and will not be selected for further screening. The breeders have noticed that seedlings with very red leaves when immature tend to produce red fruit. When bearing trees produce a new flush of growth, these immature leaves are the same colour as those of a young seedling. Our aim was to establish whether fruit colour can be predicted by immature leaf colour. Trials were conducted over two seasons using seedlings from parents of varying fruit colour. A different trial site consisting of more parent combinations was used in the second season. For the individual seedling trees, immature leaf hue was measured, and poststorage fruit were classified as red, blushed or green. In the first season, there was a significant difference between mean leaf hue for all of the fruit colour categories. In the second season there was no significant difference between the mean leaf hue for blushed and green fruit. Based on the two seasons' results, we determined that seedlings with a leaf hue of less than 55 ° can be removed, as there is minimal risk that they will produce blushed fruit. In the first season it would also have been possible to remove seedlings with a hue greater than 110 °, but this was not the case in the second season. Our conclusion is that seedlings with dark red leaves can be culled, but to cull seedlings with green leaves would carry too high a risk of losing blushed fruit.

*Keywords:* Pyrus communis, juvenility, red fruit, colour inheritance

# THE INFLUENCE OF NITROGEN AND SHADING ON GREEN COLOUR OF 'GRANNY SMITH' APPLES

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The market desires 'Granny Smith' apples with a uniform dark green colour, but many producers struggle with whitening of the peel. Green colour is largely determined by the level of chlorophylls present in the peel. Fruit were sampled from 20 orchards that had been selected based on their green colour performance in the previous season. Fruit from orchards where colour had been good the previous season, had significantly greener fruit, more peel chlorophyll and more leaf nitrogen than the poor orchards at both 80 days after full bloom (dafb) and harvest. We concluded that green colour is determined during the early stages of fruit development. In the following season we conducted a trial where different forms of N were applied at different rates and times, to see if this could improve green colour. Some of the treatments showed significant differences in green colour compared to the control at 40 and 80 dafb and harvest, but the results were inconsistent, and so slight as to be of no commercial value. None of the treatments increased peel chlorophyll, peel N or leaf N. Another trial was conducted to establish the effect of early-season shading on fruit colour. Fruit were covered with 40 % shadecloth from 2 until 8 weeks after full bloom. There was a significant loss of green colour and chlorophyll for unshaded fruit from 2 to 8 wafb. At 8 wafb and harvest there were significant differences in green colour between previously shaded and unshaded fruit. These results suggest that a strategy such as summer pruning would not improve 'Granny Smith' green colour.

*Keywords:* Malus domestica, fruit, chlorophyll, nutrition, urea, light

# RED COLOUR OF BLUSHED 'FORELLE' PEARS IS AFFECTED BY CHOICE OF ROOTSTOCK

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Insufficient red colour limits the profitability of blushed pear cultivars in South Africa. Here we report on a trial conducted to establish whether red colour can be improved by choice of rootstock. We assessed the effect of BP1, BP3, Old Home x Farmingdale 97, Quince A, Quince C51 and BA 29 rootstocks on the colour of 'Forelle' pears over two seasons. Light interception effects were negated by only sampling exposed fruit. Quince rootstocks showed the best red colour compared to the pear rootstocks. This does not appear to be related to differences in maturity between the rootstocks, because firmness correlated poorly with background colour. Chlorophyll and carotenoid concentrations of the peel were significantly lower in fruit from quince rootstocks. Differences in anthocyanin concentrations between the treatments were non-significant, although they did follow colour measurement trends. Peel and leaves from pear rootstocks contained significantly more nitrogen, which may explain their higher peel chlorophyll concentrations. Fruit from quince rootstocks most likely appeared redder due to lower chlorophyll concentrations in the peel. Our conclusion is that the different rootstocks may have a direct effect on 'Forelle' pear red colour that is not related to differences in light interception or maturity, but may in part result from differences in nitrogen concentrations.

*Keywords:* Pyrus communis, fruit, anthocyanin, chlorophyll, carotenoids, nitrogen

# CAUSES AND PREVENTION OF EXCESSIVE LEAF ABSCISSION IN THE AVOCADO (*Persea americana* MILL.) CULTIVAR RYAN

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Excessive abscission of both the spring and the summer flush leaves is a well known phenomenon for the avocado cultivar 'Ryan'. Excessive leaf abscission, especially of the summer flush, is thought to have a negative effect on fruit set and early fruit development, because the leaves that drop could be expected to play a significant role in the production of carbohydrates necessary to fuel fruit set and development. Stress-related factors, such as unfavourable climatic conditions, water deficits, nutrient deficiencies and diseases, alone or in combination, possibly contribute to excessive leaf drop. The effect of tree nutrient status, starch reserve levels, flowering, leaf area, leaf chlorophyll content and changes in anatomical structure over time on leaf abscission have been investigated during the 2006 and 2007 seasons. For both seasons data was collected at six phenological stages and compared for the cultivars 'Fuerte', 'Hass' and 'Ryan'. All the mentioned factors were correlated with leaf abscission. The three cultivars and two seasons were also compared. Applications of plant growth regulators and kaolin were made during the 2006 with the aim of improving leaf retention and fruit set. None of the treatments showed any significant effect possibly because treatments were applied too late. During 2007 earlier application were made and different combinations and products used.

*Keywords: Persea americana*, Ryan, leaf abscission, stress, growth regulators, kaolin

# ESTIMATING BULK DENSITY OF SOUTHERN AFRICAN SOILS

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Soil bulk density measurements are required as an input for a wide range of analyses, e.g. to compute soil nutrient content or soil water content on a volumetric basis. Soil bulk density measurements are also required for models that predict soil processes. Methods to measure bulk density are labour intensive and time-consuming. As a result, bulk density data are seldom measured on a routine basis during soil surveys in southern Africa and as such are frequently missing from soil databases such as the ARC-ISCW Soil Information System (Land type) and regional Soils and Terrain Digital Database for Southern Africa (SOTERSAF).

The objective of this study was to create bulk density coverage of southern African soils by predicting the oven-dried bulk density of samples in the SOTER database. This required determining the relationship between soil properties and bulk density as well as determining which of the existing regression equations fitted southern African soils best.

A total of 224 measured bulk densities of southern African soils were used. The dataset mostly comprised measured bulk density values with the total clay, silt and sand content, organic carbon, water content at –1500 kPa and horizon depth. This dataset was used for validation purposes because earlier studies showed that significant relationships exist between these variables and bulk density.

The taxotransfer approach developed by International Soil References and Information Centre (ISRIC) in 2007 showed the highest correlation value with the measured bulk densities and was subsequently used to populate the SOTERSAF database. A taxotransfer function is a means of estimating soil parameters based on modal soil characteristics of soil units from a combination of their classification name, which by definition implies a certain range of various attributes, expert knowledge and empirical rules, and statistical analysis of a large number of soil profiles belonging to the same taxon. This approach is considered appropriate for studies at scales smaller than 1: 250 000.

*Keywords:* bulk density, soil properties, SOTERSAF, taxotransfer approach

# THE INFLUENCE OF COMPONENT CROP DENSITIES AND PLANTING PATTERNS ON CROP GROWTH AND SOIL NUTRIENT CONTENT IN A DRYLAND MAIZE/COWPEA INTERCROP

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Field experiments were carried out during the 2005/2006 growing season at three localities to assess the effects of planting density and planting patterns on crop growth, maize stover nutrient concentration and residual soil nutrient content in maize/cowpea sole and intercropped systems. The trial consisted of four maize planting densities and six planting patterns.

Higher plant density of 30 000 and 40 000 maize plants $ha^{-1}$ delayed flowering and maturity of both component crops in sole and intercropped systems. Maize dry matter production increased with increasing plant density of up to 30 0000 plants $ha^{-1}$ and reduced at a higher density of 40 000 plants $ha^{-1}$, whereas cowpea dry matter production decreased with increasing plant density in intercropping but this was the opposite in sole cropping. The 1rowM:2rowsC pattern and plant density of 30 000 plants $ha^{-1}$ with 92 000 plants $ha^{-1}$ of cowpeas was superior in maize dry matter production at all trial sites, whereas sole cowpea at 40 000 plants $ha^{-1}$ gave the highest dry matter yield. The 2rowsM:4rowsC arrangement had the tallest cowpea plants, while the 1rowM:1rowC arrangement had the shortest at all locations throughout the sampling dates. The combination of all intercropping planting patterns and plant density of 10 000 plants $ha^{-1}$ gave higher nutrient concentration levels than at higher plant densities.

Sole cowpea had higher residual soil $N\text{-}NO^{-}_{3}$ yield of 1.92, 1.66 and 1.23 mg $kg^{-1}$, and residual soil $N\text{-}NH^{+}_{4}$ of 3.28, 3.44 and 3.34 mg $kg^{-1}$ compared to all intercropping planting patterns and sole maize at Syferkuil, Potchefstroom and Taung, respectively. The study indicated that intercropping systems and plant densities lower than 30 000 plants $ha^{-1}$ of maize had the potential of improving crop productivity and soil fertility status.

*Keywords:* Planting-density-and-patterns, sole-cropping, nutrient-concentration, intercropping, residual-soil-nutrients, maize-stover

# EFFECT OF IRRIGATION AND NUTRIENT LEVEL ON VEGETATIVE GROWTH AND FRUITING IN 'TRIUMPH' PERSIMMON

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The astringent persimmon cultivar, Triumph (*Diospyros kaki),* has been grown commercially in Israel for the past 2-3 decades. Planting material has been imported into South Africa 12 years ago in order to establish a Southern Hemisphere persimmon industry. Due to differences in climate, soil characteristics and cultural practices, it was necessary to establish optimum irrigation and fertilizer application levels under South African growing conditions. In this study, water and fertilizer were applied at three levels, i.e. 0.5X, 1X and 2X where 1X represents the standard water and nutrient application rate (20.4 L $h^{-1}$ water and 78, 33, 87, 43, 12 and 45 kg $ha^{-1}$ N, P, K, Ca, Mg and S, respectively) over the 2005/2006 and 2006/2007 seasons. None of the treatments affected fruit set or the number of fruit per tree. Vegetative growth, leaf area and fruit size increased linearly with irrigation level whereas fruit total soluble solids decreased. The increase in vegetative growth at higher water application rates may allow trees to fill their allotted space and attain full production sooner. Cumulative yield over the two year duration of the trial was 31, 40 and 54 t $ha^{-1}$ at the 0.5X, 1X and 2X levels of water application, respectively. This increase in yield could be attributed to the increase in fruit size at increasing levels of water application rate. Fertilizer application at any level of irrigation or 0.5X water without fertilizer application delayed fruit maturity significantly. This effect could prove advantageous by lengthening the marketing window. The storage potential of fruits that are delayed in maturity due to water deficit and fertilizer application, as well as the storability of the larger fruits produced at higher water application rates need to be assessed.

*Keywords: Diospyros kaki*, fertilizer, persimmon, Triumph

# COLOUR CHANGES IN INVOLUCRAL LEAVES OF LEUCADENDRONS – A MORPHOLOGICAL AND ULTRA-STRUCTURAL INVESTIGATION

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*Leucadendrons* undergo a remarkable colour change during their development. Active chlorophyll degradation causes involucral leaves to change from green to yellow. Previous studies indicated that this colour change was closely linked to the development of the inflorescence. The yellow phase is followed by a natural regreening process, marked by the synthesis of chlorophyll. This study aims at refining the link between the morphological development of individual florets and the observed pigment fluctuations. Furthermore the fate of chloroplasts during the degreening and regreening phases was investigated to determine whether a reversion of gerontoplast to functional chloroplast occurs, which would also be indicative of a reversion of senescence. Floral cones of the commercial cultivar Goldstrike were collected at significant colour change stages, dissected and morphological structures photographed using a stereo-microscope equipped with a digital camera. Colour measurements were taken of the corresponding involucral leaves. An ultrastructural investigation of chloroplast structure was conduced via electron microscopy. Chloroplast counts were done using a light microscope after staining ultra-thin sections (1µm) with toluidine blue. Colour development was again linked directly to the development of the inflorescence, with the first noticeable colour change coinciding with the protrusion of the fused yellow florets above the floral bracts. This phase is characterised by the maturing of nectaries and expansion of the female stigma. Involucral leaves turned bright yellow with anthesis marked by a splitting of the perianth, with male carpals curling backwards to expose a fully expanded stigma. Regreening appeared to occur after floral death, and although slightly variable only seemed to commence when the last floret had wilted. During the leaf yellowing phase, thylakoid membrane systems became increasingly loose and disorganized. A conversion of chloroplasts to gerontoplasts was confirmed by the presence of plastids with little internal membrane structure and large plastoglobuli, while retaining a structurally sound plastid envelope. Upon regreening, the internal membranes reorganised into functional chloroplasts. Chloroplast counts showed no significant change between the different phases, indicating that chloroplasts are not entirely dismantled, but remain behind as colourless plastids to be reconstructed upon regreening.

*Keywords:* colour development, regreening, chloroplast conversion, plastids, chlorophyll fluctuations, Leucadendrons

# GRAIN YIELD AND PROTEIN CONTENT OF LEAVES AND IMMATURE PODS OF TWO COWPEA VARIETIES AS INFLUENCED BY LEAF HARVESTING AND BINARY CROPPING

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The multiple uses of different parts of cowpea plant include the harvesting of its leaves during its early growth stage as vegetables for human consumption. Its production under intercropping (binary) systems, particularly on small-scale farmers' field is a common practice. Thus, an experiment was initiated to examine the effect of cowpea-leaf harvesting during the vegetative growth stage on grain yield and protein content of leaves, immature pods and dry seeds under sole and binary culture. The experiment was carried out at the University of Limpopo experimental farm during 2005/06 and 2006/07-production seasons. Treatments consisted of combinations of cowpea cultivars (Pan 311 and Red caloona), cropping systems (sole and intercropping) and cowpea-leaf pruning regimes (pruning and un-pruned). Treatments were laid out as randomized complete block (RCB) design with four replicates. Supplementary irrigation was applied during the 2-year production period. Fully expanded cowpea leaves were selectively harvested once from designated plots at five weeks after planting while fully developed but immature pods from each plot were collected for protein content determination. Grain yield from different plots were obtained at harvest and the protein content of dry seeds determined. All data generated were statistically analyzed.

Results of the 2-year study revealed a significantly higher protein content in Pan 311 than Red caloona leaves harvested prior to the reproductive stage. Protein content of immature Pan 311 pods ranged from 18.8 to 25.1% while that of Red caloona ranged from 17.9 to 20.7%, depending on leaf-pruning regimes and cropping system. Though protein content of immature pods for the 2 varieties obtained during 2005/06-production season under sole and binary culture did not differ significantly, a marginally higher value (1.8%) was obtained under sole crop during 2006/07-production season. Grain yield obtained for Pan 311 and Red caloona ranged from 1353 to 2054.4 t $ha^{-1}$ and 1179.2 to 1780.5 t $ha^{-1}$, respectively during 2005/06 and from 980.8 to 1600.6 t $ha^{-1}$ and 488.2 to 535.2 t $ha^{-1}$, respectively during the 2006/07-production season. Seed protein content varied between 23.7 and 26.3% under binary culture while values ranged from 23.7 to 25.7% under sole crop during both years; being marginally higher under binary culture. Pan 311 cowpea variety appears better than Red caloona when grown for vegetable purpose owing to higher protein content in leaves and immature pods. Its higher grain yield advantage over Red caloona under binary culture will also constitute additional benefits to the farmer.

*Keywords:* Binary culture, protein content, leaf pruning, cowpea

# POTASSIUM STATUS OF GEOLOGICALLY DIFFERENT VINEYARDS NEAR HELDERBERG, SOMERSET WEST

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Little scientific information regarding the effect of different geological mother materials on grape juice composition is currently available in South Africa. This aspect is of special significance for the Helderberg area, where parent material may change from granite to shale over a short distance, resulting in shale-derived as well as granite-derived soils often occurring within the same vineyard. The objectives of this study were to investigate relationships between (i) various indices of potassium availability, (ii) mineralogy and lithology, and (iii) K concentration in the grape juice.

Blocks of Sauvignon blanc and Cabernet Sauvignon at four localities near Helderberg, Somerset West were located on adjacent shale- and granite-derived soils. From six vines at each locality-parent material combination, grapes were sampled together with soil adjacent to the vine, providing a sample population of 48. Ammonium acetate extractable basic cations and total cations in grape juice were analysed by atomic absorption spectroscopy. Quantity-intensity (Q/I) relationships for K were studied for 16 soils by equilibrating with varying K levels in a background solution of 0.002M $CaCl_2$. Clay mineralogical composition was also investigated by X-ray diffractometry.

The soils were mineralogically very similar, dominated by kaolinite with minor amounts of mica, quartz and chlorite in the clay fraction, irrespective of parent material. No consistent differences could be observed between shale- and granite-derived soils in terms of either soil chemical properties or grape juice composition. Juice K concentration bore no consistent relationship to exchangeable K nor to standard Q/I parameters ($PBC_K$, $EAR_K$) despite the fact that the latter varied quite widely among the soils examined. However, there did appear to be some promise in using exchangeable K when expressed as a fraction of total exchangeable cations for predicting juice K concentration ($r^2$ = 0.43; n = 48), suggesting a potential application of the base cation saturation ratio (BCSR) concept in this specific context despite growing general doubt about its applicability in determining K fertilizer requirements of crops.

*Keywords:* K availability, Q/I, BCSR, wine quality

# YIELD STABILITY ANALYSIS AMONG SELECTED COWPEA VARIETIES IN THE NORTHWEST AND LIMPOPO PROVINCES OF SOUTH

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Cowpea (*Vigna unguiculata* L. Walp) is one of the important food legumes and a valuable component of the traditional cropping systems. The objective of the present study was to select high yielding and stable varieties of cowpea across a range of environments in . Field experiments were conducted under dryland using ten diverse germplasm lines at Potchefstroom and Taung (Northwest Province) and Syferkuil (Limpopo Province) over three planting dates. Cowpea plots of each genotype were in four rows each 5m long with a 1m inter row and 25cm intra-row spacing. The three planting dates implemented were [Early] 8 November, [Mid] 22 November, and [Late] 06 December 2004 at each location respectively. Yield stability analysis was carried out through joint regression and superiority analysis. The result indicated that varieties M101, M217 and IT18E-16 expressed average stability for high yield. Variety IT18E-16 is recommended for production in these or other similar environments in South Africa.

*Keywords:* Cowpea, Limpopo Province, stability, joint regression, Northwest Province

# SOYBEANS AS ROTATIONAL CROP CAN REDUCE NITROGEN REQUIREMENTS OF SUGARCANE CROPS IN THE SOUTH EASTERN LOWVELD OF ZIMBABWE

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The high nitrogen requirements of sugarcane present a problem for small scale farmers in Zimbabwe due to the high cost of fertilizer. Producing legume crops in rotation with sugarcane during the fallow period may alleviate the problem to some extent. This research was conducted on sandy clay loams at The Zimbabwe Sugar Association Experiment Station in the south eastern lowveld of Zimbabwe. The main aim of this research was to establish whether vegetable and grain soybeans used as fallow crops in sugarcane fields can increase sugarcane yield by providing additional N. Treatments were as follows: 1) Vegetable soybean treatment involved the planting of soybean in the fallow period with the soybean pods harvested as green vegetables and the remaining crop residues were incorporated into the soil immediately after harvest, 2) Grain soybean treatment involved the planting of soybeans during the fallow period buit the soybeans were left to grow to maturity before being harvested as grain. The dry soybean residues were removed from the field and only the root residues were incorporated into the soil and 3) Fallow treatment (control) where the land was fallowed. In all three treatments sugarcane was planted after the fallow period and topdressed with either 80 or 120 kg N $ha^{-1}$. Sugarcane variety CP72-2086 was used in the experiment. The following cane parameters were measured; LAI, biomass, tiller number, N content in leaves and sugarcane and sugar yield. Cane planted in vegetable soybean plots and topdressed with 80 kg N $ha^{-1}$ had significantly higher LAI, biomass, tiller number, N in leaves and cane and sugar yields than cane planted after fallow and topdressed with 80 kg N $ha^{-1}$. The vegetable soybean/80 kg N $ha^{-1}$ treatment produced about the same or higher figures than the fallow/120 kg N $ha^{-1}$ treatment in terms of the above mentioned parameters. All the measured parameters were lowest in the fallow/80 kg N $ha^{-1}$ treatment. Therefore farmers can increase their cane yield by incorporating vegetable soybeans in the system. If fertilizer costs are prohibitive, they can reduce the top-dressing of their cane to about 80 kg N $ha^{-1}$ when vegetable soyabeans are used as a fallow crop. This will help them save about 40 kg N $ha^{-1}$ and should make the cane production cycle more profitable.

*Keywords:* crops, fallowing, N fertilizer, soybeans, sugarcane, Zimbabwe

# A PRELIMINARY ANALYSIS OF BIOMASS ACCUMULATION AND PARTITIONING OF THREE SUGARCANE GENOTYPES GROWN IN FOUR CONTRASTING ENVIRONMENTS

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Sucrose yields can be increased substantially by optimally matching cultivars to the environment. Sucrose accumulation is the end product of several processes driven by climatic and genotypic factors. These are (1) radiation capture by the developing canopy, (2) the conversion of radiative energy to biomass through carbon fixation, and (3) the partitioning of the source assimilate to various plant components namely roots, stalk and leaf structure and stalk sucrose. There is limited understanding of genotypic and environmental control of these processes in general, and of S.A. sugarcane cultivars in particular and it was our aim to gain a better understanding.

Radiation capture, aboveground biomass and its constituents were measured for three cultivars ratooned in winter and in summer at Mount Edgecombe (warm coastal climate) and Bruynshill (cool Midlands climate). All trails were fully irrigated.

Cultivars N31 and N37 demonstrated quicker canopy development and more radiation capture than NCo376 at all sites and starting times. N37 had lower radiation conversion efficiency than the other two cultivars. This led to N31 producing the most aboveground biomass, followed by N37. N37 partitioned the highest fraction to leaves followed by N31, while N31 had the highest stalk structure fraction. The highest sucrose fraction was achieved by NCo376 in the warm climate, while sucrose fractions in the cool climate were unexpectedly similar for the three cultivars. The warm climate produced relatively more leaf mass than the cool climate for all cultivars. N31 produced the highest biomass and stalk yield for all sites and starting times. It also produced the highest sucrose yield, except for the October start at Mount Edgecombe, where NCo376 produced the top yield. Results suggest that a quick canopy, combined with high radiation conversion efficiency are the most important traits for all the environments tested.

*Keywords:* sugarcane, biomass, sucrose, temperature, cultivar, radiation

# INTEGRATING HARD AND SOFT SCIENCES FOR SUSTAINABLE LAND MANAGEMENT: IMPLEMENTING ECO-TECHNOLOGIES IN THREE PROVINCES OF SOUTH AFRICA

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There is a central concern in the National LandCare Programme of South Africa to implement projects that place people at "the starting point, the centre and the end of each development intervention … and constructing appropriate interventions or technology around their mode of production, cultural patterns, needs and potential". The eco-technology programme is an initiative of the National Department of Agriculture (DoA), implemented by the ARC-ISCW in three provinces (Mpumalanga, Limpopo and KwaZulu-Natal). It aims to design and implement eco- technologies, through an action research process, for the sustainable use of natural resources and benefit of all LandCare stakeholders in future.

The first major activity of this programme is to select, design and demonstrate eco-technologies from a 'basket' of sound scientific principles and sustainable resource management options. Various appropriate new and/or indigenous eco-technologies are included in this basket. For example, the agronomic and horticulture practices are based on conservation agriculture (CA) principles, which are minimum- or no-tillage, multiple cropping and mulching. Coupled with that are sound grazing management systems, water harvesting, low-cost irrigation and wise use of wetlands.

The second major activity of this project is to design and facilitate the process required to empower the relevant stakeholders with the necessary social (institutional) and human (knowledge and skills) capital. This process is designed around the six major phases of an action research cycle, namely: a) Stakeholder analysis, b) Diagnosis, c) Planning strategically, d) Implementing and managing, e) Learning and adapting, and f) Exit strategy. The intended outcomes of this process model are the creation of a culture of learning that would allow people to be innovative and interactive and to collectively care and manage natural resources in a sustainable manner. The major achievement of this programme is the setting up and facilitation of long-term processes that bring different groups into constructive engagement, dialogue and decision-making. It manages to bring the right people (i.e. the relevant stakeholders) on board and to actively involve them in various programme activities and sustainable natural resource management.

*Keywords:* Action research, sustainable agriculture, eco-technologies, multi-stakeholder processes, LandCare Programme

# INTEGRATING HARD AND SOFT SCIENCES FOR SUSTAINABLE LAND MANAGEMENT: A PHD CASE STUDY

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The aim of this PhD research was the development of action-research theories based on experiences in a South African Landcare project. The Bergville Landcare project, implemented from 2000 to 2005, was aimed at developing conservation agriculture (CA) practices in a community of resource-poor farmers. These attempts culminated in the development of a soft-system platform on which participatory action research methodologies and techniques could be based in order to facilitate adult and action learning. The approach selected for the PhD research was one in which multiple methodologies were deemed the most appropriate. The research process used the following four phases: a) initial understanding of theories; b) application of initial theories; c) data collection and theory development; and d) theoretical and practical insights.

Action research, experiential learning and action learning (initial theories) formed the foundation of the approach which was conducted with resource-poor farmers in the Bergville project. In a practical sense, action research was seen as the “umbrella methodology”, applied in harmony with other methodologies. The “action research process” applied in the Bergville project was used as the so called ‘Acting’ phase, and was the primary data source for the PhD research process. The multi-methodological data analysis and theory development process proved to be successful in establishing local theories for practical application. Cognitive maps were used in combination with a general soft systems methodology framework to stimulate data analyses, reflection, learning and ultimately theorising.

The most suitable approach for a synthesis of the theorising results appeared to be the integration of the results into an improved theoretical framework. This improved framework proved to be that of a systems model which included the major phases of the action-research cycle, and this was used to describe the proposed methodologies and techniques. The proposed six phases of this model are: a) Stakeholder analysis, b) Diagnosis (Situation analysis), c) Planning strategically, d) Implementing and managing, e) Learning and adapting, and f) Exit strategy. This model provides a means of creating a culture of learning that would allow people to be innovative and interactive in the management of natural resources and to collectively care for and manage these resources in a sustainable manner.

*Keywords:* action research, sustainable agriculture, conservation agriculture, multi-stakeholder processes, cognitive mapping

# GENOTYPIC AND TEMPERATURE CONTROL OF LEAF APPEARANCE AND STALK EXTENSION: RECENT FINDINGS FROM FIELD AND GLASSHOUSE TRIALS

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In theory plant growth and development is proportional to biological or thermal time, which can be defined as the time integral of temperature above a certain threshold. Below the threshold or base temperature (TTb) a crop does not grow or develop, and above the optimum temperature the rate starts to decline. The relationship between temperature and rate of growth or development is assumed to be cultivar specific and stable across environments. Thermal time, expressed in growing degree days ($^{o}$Cd), is easy to calculate and widely used in crop modelling. The relationship between temperature and development rate is assumed to be linear over the temperature range from the base temperature to near the optimum temperature.

The temperature control of the rate of leaf appearance (phenology) and stalk elongation (growth) was investigated for sugarcane cultivar NCo376 in a controlled environment research unit at three temperature regimes and for NCo376, N31 and N37 under field conditions at two sites. All experiments were fully irrigated and adequately fertilized. The threshold temperature TTb, was determined in one of two ways: a) as the x-intercept of a linear regression of the rate of the process versus daily mean temperatures or b) as the slope of the linear regression between leaf number or stalk length versus thermal time where the base temperature was incremented from zero to 20 in units of one and the best fit was taken as that with the highest coefficient of determination.

Results indicate that nonlinear responses to temperatures near TTb can cause the value of the x-intercept to under-predict apparent base temperature. It was easier to inspect for linearity in the second method and to distinguish between development phases that differed in base temperature. Base temperature appeared to be lower for early development stages and for the cooler climate. The apparent base temperature did not differ between crop cycles at the same site. The thermal time needed for the formation of new leaves (phyllochron) differed between sites with the warmer site having longer phyllochron duration. The response of stalk extension to temperature was significantly different between sites, cropping cycle and cultivars. Genotypic control of this relationship is strong and consistent. Low external radiation levels caused a reduction in stalk extension rate in the glasshouse, indicating a source limitation.

These impacts must be taken into account when stalk elongation or phyllochron is used to quantify plant growth status for production management and variety improvement purposes.

*Keywords:* Sugarcane, base temperature, radiation, phyllochron, genotype

# THE USE OF CHLOROPHYLL A FLUORESCENCE TO QUANTIFY HERBICIDE DAMAGE IN MAIZE

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The objective of this study was to determine if chlorophyll *a* fluorescence could be used to quantify damage in maize caused by pre-emergence herbicides. Maize cultivar CRN3505 was grown in the glasshouse. Seven pre-emergence herbicides and/or mixtures were applied at normal and double the standard dosage rates. A control treatment was included where no herbicide was applied. Total seedling emergence, visual phytotoxicity (%), plant height (cm) and dry mass (43 DAP) were measured during the trial period. Chlorophyll *a* fluorescence transients were recorded weekly for all treatments in fully dark-adapted attached leaves. The transients were analysed using the JIP test, which is quantitative analysis providing information about the energy flow through photosystem II (PSII). One of its calculated parameters, the performance index ($PI_{ABS}$), was used to quantify the degree of herbicide damage to maize. $PI_{ABS}$ is a multi-parametric expression that combines the three main functional steps taking place in PSII that can serve as an indication of the vitality of a plant. Significant differences, in which herbicide application differentially affected O-J-I-P fluorescence rise kinetics, and thus the $PI_{ABS}$, were observed between atrazine-mixtures and acetamide-herbicides. Herbicide mixtures containing acetamide/ atrazine significantly altered these kinetics in a characteristic way. These mixtures negatively affected electron transport through PSII. Herbicides and dosage rates had no significant effect on total seedling emergence. Visual phytotoxicity symptoms were significantly higher in acetamide treatments (62% and 75%, respectively). Herbicides and dosage rates had a significant effect on plant height. The most stunted plants were observed in the atrazine/s-metolachlor and acetachlor + safener treatments. A significant interaction ($P<0.025$) between herbicides and dosage rates was only observed for plant height. Results suggested that chlorophyll *a* fluorescence shows potential as a screening tool to asses herbicide damage in maize.

*Keywords:* Chlorophyll a fluorescence, herbicide damage, maize, phytotoxicity

# WATER REQUIREMENTS AND DROUGHT SENSITIVITY OF SELECTED WHEAT CULTIVARS

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Water stress is one of the most limiting factors in wheat production due to poor seasonal rainfall distribution. Consequently, in summer rainfall regions wheat is usually produced under full irrigation. For efficient irrigation management of the new high potential wheat cultivars, producers need to know their water requirements.

Field trials were conducted on a silt clay loam soil at the Hatfield Experimental Farm during 2006 and 2007. The objectives were to determine cultivar water requirements and investigate sensitivity of wheat cultivars to water stress imposed at different growth stages. Three wheat cultivars (Olifants, Duzi and Krokodil) and four water regimes were applied. Irrigation regimes included a non-stressed control (NNN), or stressed during either the vegetative stage (SNN), the flowering stage (NSN) or the kernel filling stage (NNS). Soil water deficits were measured every fourth day using a neutron probe. Additionally, soil water content was monitored continuously at 0.1 m increments with capacitance probes. Growth analyses were conducted fortnightly and final grain yield and quality were determined at harvesting.

Water stress applied during any growth stage resulted in severe reductions in total dry matter yield and leaf area index. Leaf area duration was most severely affected by water stress in the vegetative (SNN) and grain filling stages (NNS).

Grain yield was most sensitive to water stress imposed during the vegetative (SNN) and flowering (NSN) stages, with significantly lower grain yields. SNN had lowest protein content values for all three cultivars. Best protein contents were recorded for NSN, followed by the control (NNN).

Soil water profile results suggested that Duzi could extract more water from deeper soil layers (down to 600 mm). Therefore, Duzi may perform better under water scarce conditions if grown on deep soils with sufficient water storage capacity.

Minor cultivars differences in crop water requirements occurred. NNN and NNS had highest water use efficiencies in all cultivars. SNN had highest water use, but lowest yields, resulting in the lowest water use efficiency. It can be concluded that the vegetative growth stage (SNN) was most sensitive to water stress.

*Keywords:* wheat, water stress, growth stages, grain yield, quality, water requirements

# MONITORING DROUGHT IN NAMIBIA

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Namibia, as most of the other countries in southern Africa frequently experience droughts. Some of the worst droughts occurred within recent decades and severely impacted on the agricultural sector which contributes on average 9% to the gross domestic product (GDP) and provides employment for a large portion of the Namibian society. It is therefore important for decision-makers to be able to identify various types of drought in terms of intensity and spatial extend. The objective of this study was to investigate the feasibility of applying the Standardized Precipitation Index (SPI) to Namibian monthly rainfall data in order to monitor meteorological, hydrological and agricultural droughts. Another objective was to investigate whether there are any clear trends in terms of the frequency and intensity of these droughts within the available period of meteorological observations. Results indicate that calculations of the SPI over shorter periods of a month provide a good indication of below normal rainfall and hence the severity of meteorological droughts, whereas calculations over longer periods of 3 to 6 months is better suited to describe hydrological droughts. The ability to employ the SPI to monitor agricultural droughts by calculating it over periods spanning critical crop growth stages are also illustrated. No significant trends were observed within the period of modern meteorological observations which suggests that there is no clear increase in the frequency or severity of droughts in Namibia.

*Keywords:* Drought, Standardized Precipitation Index (SPI), rainfall

# POSSIBLE MODES OF ACTION FOR THE STIMULATION OF GERMINATION BY SMOKE

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Smoke stimulates germination in a number of wild and cultivated plants, irrespective of fire sensitivity. While numerous studies have attempted to elucidate the role of smoke in germination, the exact mechanism is not yet fully understood. It is, however, believed that smoke may interact with plant hormones to trigger the physiological processes which lead to germination. The recent isolation and identification of the active compound in smoke, 3-methyl-2*H*-furo[2,3-c]pyran-2-one, a butenolide compound, has allowed for more in-depth research into the role of smoke in the stimulation of germination. Smoke consists of an enormous number of compounds and thus by using the butenolide in germination studies the confounding effect of the vast array of compounds in smoke is eliminated. Lettuce (cv. Grand Rapids) and Arabidopsis thaliana seeds were treated with $10^{-8}$ to $10^{-6}$ M butenolide alone and in combination with various concentrations of gibberellic acid ($GA_3$) and abscisic acid (ABA) and allowed to germinate in the dark at 25°C, in order to determine the role of plant hormones in smoke-stimulated germination. Lettuce seeds were chosen as butenolide substitutes for the light requirement of these seeds, allowing the seeds to germinate in the dark and Arabidopsis was chosen due to the vast number of hormone biosynthesis mutants available. Arabidopsis ABA (NCED-overexpression) and GA biosynthesis (ms33) mutants were used to evaluate the impact of butenolide on germination. These mutants were chosen as ABA is known to inhibit germination, whilst GA promotes germination. In situations where ABA was elevated, through ABA overproducing Arabidopsis mutants and exogenous applications, butenolide could not stimulate germination in either lettuce or Arabidopsis seeds. However, germination of the Arabidopsis GA biosynthesis mutant, which has reduced GA levels, could be partly restored through exogenous butenolide and/or $GA_3$ applications, indicating that butenolide may stimulate germination by interacting with GA biosynthesis or signaling.

*Keywords:* germination, smoke, abscisic acid, gibberellic acid

# OPTIMIZING THE FERTILIZER VALUE OF SEWAGE SLUDGE ACCORDING TO RAINFALL REGIME, FARMING INTENSITY AND MANAGEMENT PRACTICE

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Optimizing sludge application rate on agricultural lands is crucial both from agricultural and environmental sustainability points of view. It is crucial from an agricultural point of view in terms of providing the required amount of nutrients for best crop yield without compromising the quality. It is also crucial from an environmental sustainability point of view in terms of maintaining the soil structure and improving the soil nutrient status without compromising the soil, surface water bodies and ground water. The study is in progress at East Rand Water Care Works (ERWAT), 40 km south of Pretoria. The area has an annual average rainfall of 700 mm and a sandy clay loam soil. This study is aimed at evaluating the impact of rainfall regime, farm management practice, and intensity on crop N and P uptake from municipal sludge treated soils. Each cropping system received four levels of sewage sludge, namely zero, according to norm (8 t $ha^{-1}$ $a^{-1}$), half (4 t $ha^{-1}$ $a^{-1}$) and double (16 ton $ha^{-1}$ $a^{-1}$) the norm. The sludge treatments for an irrigated maize/ oat rotation was split into two, so that half was applied for the first crop (maize) and the remaining half for the second crop (oats). However, for the dryland maize sludge treatments, all the sludge was applied at the beginning of the summer season (planting time). Maize grown under 497 mm rainfall and 16 t $ha^{-1}$ sludge utilised 180 kg N $ha^{-1}$ and 28 kg P $ha^{-1}$. A similar cultivar grown in the same place with the same amount of sludge but with an additional 440 mm irrigation utilised 492 kg N $ha^{-1}$ and 108 kg P $ha^{-1}$. The winter crop (oat) was planted immediately after harvesting the irrigated maize, to simulate an intensive farming system. Oats utilised an additional 165 kg N $ha^{-1}$ and 119 kg P $ha^{-1}$, increasing the total amount of N and P utilised within a year in the same plot to 657 kg N $ha^{-1}$ and 227 kg P $ha^{-1}$. When only grain for the 16 t $ha^{-1}$ sludge treated dryland maize was harvested 99 kg N $ha^{-1}$ and 17 kg P $ha^{-1}$ was exported compared to 180 kg N $ha^{-1}$ and 28 kg P $ha^{-1}$ with complete crop removal. Similarly, harvesting only the grain for the 16 t $ha^{-1}$ sludge treated irrigated maize/oats rotation exported 396 kg N $ha^{-1}$ and 112 kg P $ha^{-1}$ compared to 657 kg N $ha^{-1}$ and 227 kg P $ha^{-1}$ with complete crop removal. Therefore; upper limit sludge application rate should take into account rainfall regime, farming intensity, and management practice.

*Keywords:* Sludge, nitrogen, phosphorus, farming systems, rainfall regime, farming intensity

# SEASONAL CHANGES OF ANTIOXIDANT CAPACITY, ASCORBIC ACID, TOTAL PHENOLS AND C7 SUGAR ALCOHOLS OF FRUIT AND LEAF TISSUES OF 'HASS' AVOCADO

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The pre-harvest level of antioxidants is possibly one of the major determining factors of the post-harvest storage capability of avocado fruit. Little work has been carried out determining seasonal levels of antioxidants in various fruit tissues. The level of certain antioxidants was investigated in various fruit tissues as well leaf tissue of avocado over the growing season. Total antioxidant activity, ascorbic acid and total phenols were found to be higher in leaf, exocarp and seed tissue; however, the antioxidant concentrations in the mesocarp tissue was lower than in other tissues at all sampling dates. The various tissues examined had different predominant antioxidant systems: ascorbic acid and total phenols were found to be the main antioxidants in the seed, rind tissue and leaf tissue. In mesocarp tissue; however, C7 sugars, and particularly mannoheptulose, were found to be the major antioxidant. Levels of mesocarp C7 sugars declined significantly as harvest maturity was approached; this reduction in C7 sugars could be related to the deterioration in postharvest quality. Therefore, management practices should be established to increase the concentration of antioxidants in the seed, exocarp and mesocarp tissues of fruit prior to harvesting.

*Keywords:* avocado, C7 sugars, phenolics, antioxidants, ascorbic acid

# AN INVESTIGATION INTO VARIATION OF COLOUR TRAITS IN APPLE BREEDING FAMILIES

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The objective of this study was to evaluate colour variability in the flesh and peel of progenies derived from a red-fleshed apple selection 'KAZ 91' (*Malus niedzwetkyana* Dieck.) and non-red flesh cultivars (KAZ 89, Meran and Treco Red Gala) (*Malus domestica* Borkh.) in order to develop a novel pink/red-fleshed apple suitable for the fresh consumer market. External fruit colour, blush coverage, and anthocyanin and phenolic levels in the peel and flesh (family 1 only) were measured. Family 1 ('KAZ 91' x 'Meran') differed significantly from family 2 ('KAZ 89' X 'Treco Red Gala') and family 3 ('Meran' X 'Treco Red Gala') in peel colour, fruit of family 1 being on average more and darker red with higher anthocyanin concentrations and greater blush coverage. Only family 1 had red-fleshed fruits (25 % of seedlings). Varying intensities and patterns of red pigmentation, i.e., red cortex and core or white core and red cortex, were observed. The intensity of red pigmentation in the flesh also varied between individual apples of the same seedling. This needs to be quantified in further studies. A higher total phenolic concentration was observed in the peel of family 1 compared to family 2. Family 1 flesh also had high total phenolics. Anthocyanin concentrations in the flesh of family 1 fruit correlated with the total phenolic concentrations in their peel, but anthocyanin concentrations in the peel and flesh were not correlated. These results indicate that a novel red-fleshed cultivar can be bred using the *Malus niedzwetkyana* Dieck. selection 'KAZ 91' as parent. The high anthocyanin and total phenolic levels in the skin and flesh of 'KAZ 91' progenies could have potential health benefits. Consumer preference for red-fleshed apples needs to be established.

*Keywords: Malus niedzwetkyana*, anthocyanin, red flesh

# THE INFLUENCE OF SPATIAL ARRANGEMENT ON THE COMPONENTS OF WHEAT YIELD IN CONSERVATION TILLAGE SYSTEMS IN THE SOUTHERN CAPE

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When plants are arranged in a grid-like fashion or spread out more or less evenly (as happens in the broadcast planting method), competition between individual plants for resources (water and nutrition) are minimised. With such arrangements, high planting densities can be used to increase the number of heads per unit area under dry-land production in the Western Cape. In the Western Cape, competition between plants has always been kept to the minimum by keeping row widths narrow (175-180 mm). Conservation tillage, however requires the use of wider row widths for increased stubble handling, which increases competition between plants in the row. The effect of wider row widths on the components of yield and grain yield in the Southern Cape was not known for the no-till planting method when it is used within conservation tillage systems. Trials were conducted over two seasons (2005 and 2006) at three localities in the Southern Cape region (Riversdale, Swellendam, Caledon). These factorial trials were planted with a experimental size DBS–Multistream, airseeder and treatments included different cultivars in different row widths (250-300 mm) and at varying ranges of target planting densities. Results indicated that the row widths and planting density treatments applied, significantly affected various components of yield (heads $m^{-2}$, heads $plant^{-1}$, kernels $head^{-1}$ and kernel weight). Increasing row width reduced the number of heads $m^{-2}$ at most localities, while increasing planting densities increased the number of heads $m^{-2}$. Low planting densities were compensated for by increased tillering and numbers of heads $plant^{-1}$. Grain yield was significantly reduced by increasing row width in two out of five trials, while the crop seems to be fairly insensitive to reduction in planting density in this region especially if planted early. Although grain yield was not reduced by row width in all cases, the risk of yield reduction due to increasing row widths in this region could not be excluded by this study. Planting densities can be reduced slightly from the normal 200 plants $m^{-2}$ recommendation.

*Keywords:* Yield components, row width, planting density, no-till, Southern Cape

# THE INFLUENCE OF SPATIAL ARRANGEMENT ON THE COMPONENTS OF WHEAT YIELD IN CONSERVATION TILLAGE SYSTEMS IN THE SWARTLAND

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Row widths for wheat production in the Swartland have always been kept narrow to reduce competition in the plant row to the minimum. However, conservation tillage systems require the use of wider row widths for stubble management purposes. The effect of wider row widths on the components of yield and grain yield in the Swartland is not known for the no-till planting method. Trials were conducted over two seasons (2005 and 2006) at two localities in this region (Moorreesburg and Hopefield). These factorial trials were planted with a experimental size DBS–Multistream, airseeder and treatments included different cultivars in different row widths (250-350 mm) and planting densities equal to 100,175 and 250 target plants $m^{-2}$. Results indicated that the row widths and planting density treatments applied, significantly affected various components of yield (heads $m^{-2}$, heads $plant^{-1}$, kernels $head^{-1}$ and kernel weight). Increasing row width reduced the number of heads $m^{-2}$ at all localities, while increasing planting densities increased the number of heads $m^{-2}$ only in 2006. Low planting densities were compensated for by increased tillering and numbers of heads $plant^{-1}$. Grain yield was significantly reduced by increasing row width in Hopefield during both seasons but planting density influenced grain yield in three out of the four trials, indicating that the crop is sensitive to reduction in planting density in this region, especially when planted late. Although grain yield was not reduced by row width in all cases, the risk of yield reduction due to increasing row widths could not be excluded by this study and therefore row widths should be kept as narrow as is practically possible.

*Keywords:* Yield components, row width, planting density, no-till, Swartland

## PHYTOSANITARY ISSUES IN SOUTH AFRICA

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The Directorate Plant Health (D:PH) of the Department of Agriculture (DOA) regulates importation of plants and plants products in terms of Agricultural Pest Act, 1983 (Act No. 36 of 1983). This act safe guards agricultural resources as well as the environment in South Africa by preventing the introduction of potential harmful foreign pests including weeds. South Africa is a member of World Trade Organization on application of Sanitary and Phytosanitary measures (WTO-SPS Agreement) as well as the International Plant Protection Convention (IPPC) which is recognized by World Trade Organization as a standard setting body for phytosanitary (plant health) issues. The IPPC established International Standards of Phytosanitary measures (ISPMs) to provide norms for safe and fair international trade.

Before plants and plants products are imported to South Africa the importer should apply for an import permit. A weed risk assessment will be conducted as part of the Pest Risk Analysis process which aims to prevent the introduction and spread of a plant that is likely to become a weed in South Africa. The weed risk assessment process is design to detect which species is permitted and which are prohibited entries.

*Keywords:* IPPC, WRA, WTO

# MOLECULAR MAPPING OF NOVEL RESISTANCE TO WHEAT STEM RUST WITH REFERENCE TO RACE TTKS (OR UG99)

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*Puccinia graminis f. sp. tritici,* the causal agent of wheat stem rust, has emerged as a serious threat in Eastern Africa where a new race (TTKS, or commonly known as Ug99) has been reported. This race poses a serious threat to wheat production worldwide. The stem rust resistance gene Sr36, derived from T. timopheevii, confers a high level of resistance to TTKS, and is present in a very few wheat cultivars. The objective of this study was to identify and validate DNA markers for detection of Sr36 in wheat breeding programs. Two mapping populations of 122 $F_2$ (LMPG-6 x Sr36/9*LMPG) and 112 $F_2$ ('Chinese Spring' x W2691Sr36) were evaluated for stem rust reaction. Both populations exhibited distorted segregation with a preferential transmission of the Sr36-carrying segment. We are currently pursuing cytogenetic analysis to investigate the causes of preferential transmission involving this alien chromosome fragment. Three microsatellite markers, Xstm773-2, Xgwm319, and Xwmc477, were in complete linkage with Sr36in one population. In the other population, Xgwm319 was 0.9 cM away from Xstm773-2, Xwmc477,and Sr36. These co-dominant markers were easy to score and were diagnostic for Sr36 in a diverse set of 76 wheat cultivars and breeding lines developed in 12 countries. Together, these markers are now being used by several wheat breeding programs as part of marker-assisted selection of Sr36 and also in pyramiding this gene with other stem rust resistance genes.

*Keywords:* Marker-assisted selection, Stem rust resistance gene, TTKS

# VIRTUAL SOIL PROFILES: A COLLECTIVE STATEMENT OF GENERALIZED SOIL PROPERTIES

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"What may we expect of the soils of this district, of their properties or suitability for an agricultural enterprise?" A generalized statement of the chemical, physical and micronutrient properties for soils classified within a soil taxonomic class will be of benefit to many sectors of the agricultural industry. Agriculturalists have derived considerable benefit from the pedological interpretation of soils based on morphological and formal soil classification. Usually, these interpretations are supplemented by soil property analyses from individual soil profiles representing only single point locations in the landscape. This paper proposes a stratification method, grouping similarly classified soil profiles to evaluate mean values for commonly determined soil properties. The paper then demonstrates mean soil physical, chemical and micronutrient property values for selected soils overlying sandstone of the Vryheid Formation, Ecca Group.

A computerized selection program, established using MS Access, facilitates the selection of soil profiles from the ARC-ISCW Soil Profile Information System. The philosophy considers that similarly classified profiles overlying a defined geological formation, and within a narrow rainfall range and geographical location, should exhibit narrow ranges in property values. The resultant mean or quartile range values could then represent central soil property values for the dominant soils of the district.

The Soil Statistics Program selects profiles from within a defined geological formation, soil form, soil horizon, rainfall range and district location. Options to select for a single entity (a single geological formation) or group (several similar soil forms) are provided. Data can be viewed before calculating mean, median, standard deviation, lower and upper quartile values and a count. Displays for physical, chemical, micronutrient and saturation extract values are made per horizon. The Archive Program then reconstructs the sequence of horizons while adding Soil Form and Identification Information to give a virtual soil profile. An index based on province, geological formation, soil form, and rainfall range allows easy access to the reports expressed in mean or quartile range formats. The paper discusses mean results from selected Avalon soil profiles. This virtual profile information combining expert pedological knowledge with statistical mean values could supplement soil interpretation procedures in agricultural and environmental disciplines.

Keywords: Soil profile analyses, soil classification, soil properties

## STEENKOPPIES AQUIFER: A GROUNDWATER RESOURCE UNDER STRESS

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The Steenkoppies Compartment, a dolomitic aquifer, situated on the West Rand, has a natural outflow at a perennial spring named Maloney's Eye, which feeds the Magalies River that flows into Hartbeespoort Dam. An all time low outflow from Maloney's Eye and subsequent decrease in flow of the Magalies River, resulted in proposed water restrictions. The reduction in flow was attributed to increased abstraction of water for irrigation purposes.

The objectives of the study were to determine the socio economic impact of water restriction on the irrigation community and to evaluate the conceptual model for water flow from Maloney's Eye and Magalies River.

Information on the socio economic impact of water restrictions was determined through a semi-structured questionnaire. The collected information indicated that production of vegetables and flowers occur on approximately 2600 ha with an annual turnover of about R 500 million and capital investments exceeding R 750 million. More than 3500 employees have a collective annual wage bill in excess of R 75 million. Published reports together with most recent time-series groundwater levels, stream flow and precipitation monitoring data were used to evaluate the conceptual model. Results indicated that the Magalies River receives a small component of its flow from Maloney's Eye and the largest portion is from surface water inflow and baseflow, generated down gradient from Maloney's Eye. The decrease in flow of the Magalies River are influenced by below average rainfall conditions, invasive alien vegetation and changes in the flow contribution of various tributaries of the Magalies River downstream of Maloney's Eye. The current decrease in flow at Maloney's Eye is the cumulative impact of sustained groundwater abstraction and poor recharge of the aquifer due to below average rainfall conditions.

*Keywords:* Steenkoppies Compartment, Maloney's Eye, dolomitic aquifer

# EFFECTS OF PLANTING DATE AND IRRIGATION STRATEGY ON THE YIELD OF CHINESE CABBAGE IN THE NORTH OF LIMPOPO PROVINCE

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In the Vhembe District of Limpopo Province non-heading Chinese cabbage (*Brassica rapa* L. subsp. chinensis) is a popular African leafy vegetable that is grown mostly during winter in home gardens and on smallholder irrigation schemes. In this study the effects of planting date and irrigation strategy on the yield of this crop were investigated. Marketing of Chinese cabbage in Vhembe is constrained as a result of the fairly narrow planting date window that farmers use. This causes supply to exceed demand from about mid-June until the end of July. Institutional arrangements that apply to the sharing of water among farmers on smallholder canal schemes limit the frequency of irrigation of plots to once per week and this may cause a degree of water stress and a concomitant reduction in the yield of crops, including Chinese cabbage. The study involved two sets of field experiments that were conducted on a deep Hutton soil at Dzindi Irrigation Scheme near Thohoyandou, using dabadaba, one of the commonly used farmer selections of Chinese cabbage. In both sets of experiments plant nutrients were applied at adequate rates. Three irrigated experiments involving the sequential planting of Chinese cabbage showed that maximum yield (2.5-3 kg fresh marketable leaves $m^{-2}$) was obtained when the crop was planted from 25 May to 2 July, with yields declining rapidly when planting date was delayed and more gradually when brought forward. Two experiments involving five irrigation strategies showed that the yield of the crop could be increased by modifying the existing irrigation strategy used by farmers, which consisted of a single irrigation of about 20 mm per week before planting followed by applying 20 mm per week during the growing season. High-frequency irrigation that maintained the soil profile close to field capacity resulted in the highest yield but in practice this strategy was not suitable for adoption by farmers. Modifying existing irrigation practices by doubling the irrigation frequency was second best in terms of the yield of fresh marketable leaves but required modification of the institutional water sharing arrangements. Charging the profile to field capacity before planting followed by single applications of 20 mm per week, an application of the deficit irrigation approach, increased yield significantly compared to existing practice. This strategy was also water use efficient and adapted to the institutional context, making it suitable for adoption by local smallholders.

*Keywords:* Sequential planting, irrigation*, Brassica rapa* L. subsp. chinensis*,* dabadaba

# MODEL-BASED DECISION SUPPORT IN THE SOUTH AFRICAN SUGARCANE INDUSTRY: HOW USEFUL IS IT?

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This contribution describes the use and perceived usefulness of three decision support systems (DSS) that have at their core the sugarcane growth model Canesim, developed at the South African Sugarcane Research Institute (SASRI): (1) SQR-Canesim, a desk-top version of the model allowing users to run their own simulations; (2) the Canesim crop forecasting system which provides monthly estimates of sugarcane production at sub-regional level; and (3) the MyCanesim system which provides field-specific daily irrigation advice and yield estimates to small-scale growers, by SMS. Interviews were conducted with registered users of the systems; as well as with SASRI research and extension staff. Uptake of SQR-Canesim was found to be very low. Those who do use it (mainly researchers and advisers) perceive it as useful for yield benchmarking or irrigation scheduling. The crop forecasting has a larger and more diverse group of users, for purposes like benchmarking of regional yields, financial planning, planning of the milling season and future sugar sales. The irrigation advice from the MyCanesim system has 75% uptake among the target group. Evidence of tangible benefits includes higher yields with less irrigation water. The results confirmed the existing feeling that the level of DSS utilisation in the industry is well below its potential. Those who do use DSS generally found them to be very useful and to help them in their jobs, whereas even most stakeholders that don't use DSS expressed a positive attitude towards them, while pointing towards lack of awareness and lack of ease of use as the most prominent reasons for not using them. Aspects regarding the complexity of quantifying the usefulness of DSS will be discussed.

Keywords: modelling, decision support systems, sugarcane, adoption

# IMPROVING WATER, SALT AND NUTRIENT MANAGEMENT THROUGH THE USE OF SOLUTE SIGNATURES

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Integrated water, salt and nutrient management is essential in achieving efficient irrigation scheduling, especially in intensively managed cropping systems and areas irrigated with poor quality water. Reducing percolation and nutrient leaching while maintaining low levels of salinity in the root zone are primary objectives. In addition to scheduling irrigation according to soil water status, solute signatures, which are an indication of the temporal and spatial occurrence of solute concentrations in soils, can be used to guide irrigation decisions. For example, accumulation of salts in the root zone can indicate insufficient leaching and provide information on the timing and quantity of subsequent leaching events required. Alternatively, the lack of accumulation of salts in the root zone can indicate a high leaching fraction which may result in the loss of valuable fertilizer. In this presentation we interpret soil solution samples analyzed for electrical conductivity (EC), nitrate ($NO_3^-$) and phosphate ($PO_4^{3-}$). Data from a drainage lysimeter trial with swiss chard (Beta vulgaris ssp. cicla) is used as example. The application of tools such as ceramic suction cups, wetting front detectors and capacitance probes to monitor solute movement are assessed. Finally, simple mass-balance calculations as well as more complex modelling approaches involving the newly developed SWBSci as learning and decision management tools are discussed.

Keywords: nitrogen, phosphorus, solute, salinity, modelling

# LUCKY PLANT™: A NATURAL PLANT GROWTH STIMULANT INDUCING PLANT DEFENSE RESPONSES

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Recent interest in organic farming as well as a sharp increase in the application of natural products in the horticultural as well as the house and home garden industries can be attributed to consumer resistance towards the use of synthetic products. This prompted a study on wild plant extracts that lead to the development of Lucky Plant™ by a team of researchers at the UFS over the past seven years. Qualitative and quantitative assessment of selected home and garden plants as well as turf grass treated with the original crude plant extract supplied **morphological** evidence of the extract's ability to elevate plant vigour and to enhance both root and above soil part growth. Further, a field trial on pansies revealed a significant property of the product namely that it induces flower bud formation leading to not only more flowers but also larger flowers and extended flowering time. Additionally, Lucky Plant™ improves overall plant health by enhancing the **natural resistance** of house and garden plants towards abiotic and/or biotic stress factors. A greenhouse trial on turf grass and selected garden plants treated with Lucky Plant™ showed an increased ability of treated plants to survive heat and drought conditions. What is especially appealing is mounting evidence that even hybrids or cultivars not known for their tolerance against stress conditions can be manipulated exogenously by triggering endogenous plant defence responses. **Molecular-biological** evidence supporting the latter will be shown. Laboratory trials revealed that treatment with Lucky Plant™ enhances the respiration rate in monoculture yeast cells, pointing towards its ability to manipulate **physiological processes** and the energy status of plants. The **action mechanism** of Lucky Plant™ with regard to the aspects highlighted in bold has been elucidated to a large extent and will be discussed respectively.

Keywords: Lucky Plant™, plant growth stimulant, Natural resistance

# TOWARDS THE DEFINITION OF SOIL INDICATORS FOR WETLAND DELINEATION

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Wetland soils are defined as soils that are saturated with water in the growing season. This saturation with water, however, leads to distinct soil morphology – often called redox morphology. Evidence of soil water saturation should further be within the plant rooting depth – normally taken as between 300 and 500 mm. The aim of this paper is to define soil indicators for wetlands, based on soil redox chemistry and morphology. Indicators of soil water saturation are an accumulation of organic matter, redox accumulations and redox depletions. Organic matter accumulations are in the form of organic soil material, mucky mineral soil material or mineral soil material with a dark colour. Redox accumulations develop when iron (Fe) and manganese (Mn) accumulate under reduced soil conditions due to water saturation to form Fe and Mn masses, pore linings, mottles and/or concretions. Redox depletions occur when Fe and Mn are removed from the soil, leaving gray mottles, root channels, ped faces or a gray matrix. Soil indicators for wetland conditions can therefore be defined as soils which have accumulated organic matter, Fe and/or Mn accumulations or Fe and/or Mn depletions in the upper 500 mm of the soil. The scope of these need to be quantified for different climatic and geologic regions, as these would impact on the manifestation of accumulations or depletions. These soil indicators can be related to soil classification to facilitate interpretation of soil maps for wetland delineation.

Keywords: Indicators, redox, soil, wetlands, Fe

# EFFECTS OF GEOLOGY, CLAY MINERALOGY AND ALTITUDE ON VINE PERFORMANCE AND WINE STYLE IN SAUVIGNON BLANC

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As part of a wider interdisciplinary study, an investigation was carried out to determine the effects of geology, clay mineralogy and altitude on the performance of Sauvignon blanc vines, and on wine style and quality, in six, 10-year old, commercial, dryland vineyards in the Stellenbosch district of the Western Cape.

At most sites increasing clay-fraction kaolinite content was associated with a decrease in vegetative growth, overall wine quality and fresh vegetative character. Conversely, increases in clay-fraction quartz content (and decreasing kaolinite) were linked with higher overall wine quality. Increased shoot growth affected fresh vegetative character positively. Since vegetative growth tended to improve with altitude, the existence in Sauvignon blanc of a link between altitude and increasing wine quality appears probable. However, because temperature tended to decrease with altitude it was not possible to distinguish between the effects of altitude and those of temperature.

Where the kaolinite content of the clay fraction was low and the altitude high, wines produced from vines growing on both phyllitic shales and porphyritic granite were of similarly high quality. A direct relationship between soil parent material and vine growth/wine character was not established. The lowest quality wines were produced from vines on hornfels. Most of the hornfels-derived soils were located at low altitude and contained relative abundances of clay-fraction kaolinite. Potassium was particularly abundant in the shale-derived soils that contained large amounts of kaolinite in the clay fraction. Potassium could have contributed to the poorer wine quality that was associated with these soils.

In view of the linkage established by this work between clay mineralogy and altitude, it is evident that land form and topography play a significant role in determining vineyard performance in the Western Cape, at least in Sauvignon blanc.

*Keywords*: altitude, clay mineralogy, kaolinite, Sauvignon blanc, vineyard, wine style

# SOIL PROPERTIES AS INDICATORS OF HILLSLOPE HYDROLOGY

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Water plays a primary role in soil genesis and soil strongly influences hydrological processes (flow paths, residence times and storage). This interaction between soil and water creates a relationship between soils and hydrology that is worth while pursuing. Morphological soil properties called pedofeatures serve as indicators of hillslope hydrological behaviour and can facilitate predictions in ungauged basins. Three catchments in the Bedford district (B3, B4 and B5) were surveyed for hydropedological purposes and the observed pedofeatures and related geological, topographical and vegetation features are interpreted. In B4 and B5, shallow soils are the dominant factor governing overland flow promoting short residence times. Deeper soils and relatively fractured bedrock in B3 facilitate bedrock flow and recharge of regional and phreatic water tables. The presence of lime and mottles in the subsoils of valley bottom soils confirm some phreatic water table activity.

*Keywords:* Hillslope behaviour, prediction in ungauged basins flowpaths

# IDENTIFYING AND EVALUATING THE EFFECT OF BT MAIZE ON PRIORITY LEPIDOPTERA SPECIES

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Transgenic Bt maize (MON810) expressing Cry1Ab protein is used to control, Busseola fusca and Chilo partellus in South Africa. Before this study no information was available on the diversity of Lepidoptera on maize in South Africa or the potential impact of Bt maize on non-target Lepidoptera species. There was also no information on the susceptibility to Bt maize to other important maize pest species, such as Sesamia calamistis, and Agrotis segetum which are not target species. The aims of this study were to determine which Lepidoptera species occur and feed on maize and could be directly exposed to Bt toxin and to assess the levels of infestation of target stem borer species and non-target Lepidoptera species on Bt- and non-Bt fields. The susceptibility to Bt maize of other maize pest were also evaluated. Field collections of Lepidoptera that were directly exposed to Bt toxin through feeding were done during two growing seasons. An ecological model was used to develop a selection matrix through which priority species were identified for research and monitoring. Identified Lepidoptera species were evaluated through field surveys, greenhouse- and laboratory experiments. Field surveys were conducted in the North-West, Free State, Gauteng and Limpopo provinces. In order to quantify infestation levels and incidence of larvae on plants, sampling was done by inspecting between 300 – 900 plants per field. Studies were also done to compare the incidence of damaged plants and larvae between Bt- and adjacent non-Bt maize fields. The susceptibility of S. calamistis and A. segetum to several Bt maize hybrids were evaluated under laboratory and greenhouse conditions. Fifteen Lepidoptera species that are associated with maize were collected. Eleven species were recorded to feed on non-Bt maize while pupae of four species were found on maize. Six of these species were recorded to feed on Bt maize and were reared on Bt maize until the adult stage. The identified priority species considering the maximum potential exposure to Bt toxin were S. calamistis, Helicoverpa armigera, Acantholeucania loreyi, Eublemma gayneri, A. segetum and Spodoptera exigua. Although Bt maize was damaged by several species of leaf, stem and ear feeding Lepidoptera, the incidence of damage was always significantly lower on Bt maize than non-Bt fields. Bt maize was shown to be highly toxic to S. calamistis. Sesamia calamistis moths did not differentiate between Bt and non-Bt plants in oviposition experiments. This study provided base line data on Lepidoptera that feed on Bt maize in South Africa. It also forms a guideline on how to prioritize important species for testing in ecologically realistic experiments. Knowledge gaps were also identified for future research.

*Keywords*: Lepidoptera, priority species, stem borers, transgenic maize

# EFFECT OF 2,4-DICHLOROPHENOXYACETIC ACID (2,4-D) ON THE SIZE OF THE NAVEL END OF NAVEL ORANGES-A PRELIMINARY STUDY

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Large, protruding navel ends of navel oranges is a major cull factor in the packhouse. Work in Chile on Lane Late navel trees suggest that the synthetic auxin, 2,4-dichlorophenoxyacetic acid (2,4-D), applied at full bloom at 20 ppm reduced the size of the navel end and increased the percentage of closed navel ends, with no effect on the number of fruit per tree and yield. To examine the use of 2,4-D under South African conditions and to determine if such a treatment would result in any negative effects on external and internal fruit quality, a preliminary study was undertaken. Palmer, Robyn and Lane Late navel trees were sprayed with 2,4-D at 25 ppm at petal drop in 2006. At harvest time in 2007 external and internal fruit quality was evaluated. 2,4-D application on Palmer Navel trees increased the percentage of closed navel ends and decreased average navel end size. 2,4-D had no effect on fruit height, fruit shape or peel thickness, but treated fruit had slightly coarser rinds. Treated fruit had greener navel ends as well as greener colour. There were no differences in internal fruit quality, although the reduced TSS and juice percentage in treated fruit may be of commercial importance. Granulation was not visible in any of the fruit sampled. Other negative treatment effects include curled leaves of the spring flush. Similar results on fruit quality were observed in fruit from treated Robyn and Lane Late trees. Future studies will be conducted to determine optimal concentration and timing of application with reduced negative effects on fruit quality.

*Keywords*: citrus, internal fruit quality, external fruit quality, leaf curling

# OVERVIEW OF CURRENT WORKING FOR WATER-FUNDED RESEARCH ON ALIEN INVADER PLANTS

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As part of its integrated strategic approach to the prevention and management of invasive alien plants in South Africa, the Directorate: Working for Water (WfW) currently invests about R18 million per annum (or 4.5% of its total annual budget) in research. Broadly speaking, 71% of this funding is spent on biocontrol, 21% on monitoring & evaluation and 5% on prioritization research.

The biocontrol research is aimed at the development and evaluation of biocontrol agents against thirty-nine terrestrial and five aquatic weed species.

The monitoring and evaluation research is focused on the development of a cost-effective, objective, statistically sound and repeatable environmental weed distribution monitoring system; together with an update of the Southern African Plant Invaders Atlas (SAPIA). In addition, backing is provided for conducting studies on species that can be successfully quantified by means of remote sensing and the development of a minimum set of indicators to underpin the implementation of a monitoring and evaluation programme within WfW.

The prioritization research is directed towards assessing the water consumption for areas cleared by WfW and making comparisons between species in these areas, and selecting and completing pair-wise comparisons of appropriate criteria for the ranking of invasive alien species and areas through expert workshops.

WfW also collaborates with, amongst others, the Water Research Commission, DST-NRF Centre of Excellence for Invasion Biology and the UKZN School of Environmental Sciences.

A Research Advisory Panel (RAP) advises WfW on policy, strategy, priorities for; and expenditures on; its various research efforts and provides an integrated multidisciplinary perspective of the entire WfW research effort. It provides an overview function relating to the quality and effectiveness of the research being supported by WfW.

*Keywords*: Working for Water, research, biocontrol, monitoring & evaluation, prioritisation

# SOIL PARENT MATERIAL: A POTENTIAL VINE PERFORMANCE AND WINE-STYLE DETERMINING FACTOR

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The main rock types underlying the coastal region are granite and shale. Fragments derived from these rocks, together with their heavily weathered breakdown products, form the parent materials in which the soil profiles of the region developed. During the protracted process of pedogenesis the minerals underwent further modification, notably conversion to kaolinitic clay. The relative contribution made by granite and shale derived materials, plus the component of quartzitic material derived from the sandstone highlands, varies from locality to locality, and even from one soil horizon to the next.

An unanswered question is whether contrasting soil parent materials affect grape vine performance and wine style. A possible reason for suspecting that this may be so stems from the supposed sensitivity of grapevines to potassium (K) supply, and the fact that, based on earlier analyses and pot trials, mainly granite-derived soils contain more K, but are less well able to regulate its delivery for root uptake than shale derived soils. Grasses grown on granite soils were found to accumulate more K, but generate less dry mass, than grasses grown on shale soils. Based on these tentative observations it was thought possible that soils derived from parent materials that differ in mineralogy may affect vine performance and wine style. To test this hypothesis under semi-controlled conditions, the compartments in a drainage lysimeter were filled with soils from deflating hilltop sites underlain by granite and shale. Merlot vines on 101-14 Mgt and Richter 99 rootstocks were planted in winter 2005, two per 1.5 m x 3.0 m lysimeter compartment. With the exception of K, mineral nutrients, lime and sprays were applied in accordance with normal practice.

Analysis showed that the granite soil contained more total potassium than the shale soil, and contained more K in Bray II extractable form. Much of this K appears to be located in degrading potassium feldspar and mica minerals in the silt and sand fractions. The shale soil had a relatively high cation exchange capacity, probably reflecting the presence of K-selective layered silicate minerals. Data obtained from the Merlot vines to date show that, on both rootstocks, leaf blade potassium concentrations are higher in granite- than in shale-grown vines, and that growth, as indicated by cane mass, is greater in vines grown on granite than on shale soil. These results agree with those obtained in the earlier work. Analysis of the grapes from the first crop will provide further data.

The purpose of this presentation is to describe the evolution and testing of a hypothesis , from glasshouse to near field scale, and to illustrate the reactions and supply of K from contrasting soil mineral assemblages, and its utilisation by grasses and vines.

*Keywords*: Granite, mineralogy potassium, grapevine, shale, soil

# EVALUATION OF TWO SEED COATINGS ON THE GERMINATION OF MAIZE

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The majority of South Africa's annual maize crop depends on rain, an input which in many seasons is erratic and unreliable. One strategy to manage this is to ensure that the early growth phase, when the roots elongate rapidly, is not hampered and is completed in as short a time as possible. The germinating seed has a limited amount of nutrients to support early growth and by coating the seed with nutrients the possibility of nutrients limiting growth in the early stages is reduced.

Omnia Fertilizer has developed two seed coatings and this trial investigated the benefit and possible phytotoxic effects on maize germination and establishment. Maize seeds were coated with the seed coatings at 2, 5, 6 or 10 L/tonne seed and compared to a control (0 L/tonne) in a complete randomised design. The plants were grown on a sandy soil in a greenhouse and fertilized with standard granular fertilizers at sufficient rates.

Ten days after planting both treatments had a higher germination percentage as compared to the control, though by day 14 there was no longer a statistical difference. Measurements of shoot length at 14 days show a marked difference with the treated plants being double the height of the control. No differences were observed between application rates or between the two formulations.

The seed coatings were not phytotoxic at the rates tested. Germination and early vegetative development were enhanced indicating that these products will assist farmers to manage the risk of not establishing a uniform stand.

*Keywords*: Maize seed, coating, germination

# FACTORS AFFECTING VEGETABLE PRODUCTION IN FOOD GARDENS OF KHAYELITSHA

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Khayelitsha is one of the poorest communities in the Cape flats region of the Western Cape, with relatively low levels of employment and literacy amongst women . Assistance is provided in the form of the establishment and maintenance of a small number of sustainable food security gardens in locations identified by the local government in collaboration with ARC researchers. The objectives of the project are research (soil and plant nutrition, disease and pest management) and technology transfer. Vegetable production was monitored in 4 garden in Khayelitsha. At each site the soils were analysed before and 3 months after augmentation with compost, and after each crop harvest for soil pH, resistance, phosphorus, sulphur, potassium, base saturation, trace elements and carbon. Diseases and pest outbreaks were monitored during crop growth and yields and nutritional status (N, P, K, Ca and Mg) were determined. From these studies a number of the factors that led to poor quality and low yields were identified. These may have included: texture (sandy soils), low soil organic matter contents and the presence of root nematode populations. Further factors were a lack of skills in basic soil management and in the management and maintenance of vegetable gardens. These factors will be addressed in greater detail in the paper.

*Keywords*: vegetable production, soil, management, diseases, nutrition, sustainability

# EFFECT OF SEEDING RATE AND NITROGEN SIDE-DRESSING ON DRYBEAN SEED PRODUCTION

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Drybeans (*Phaseolus vulgaris* L.) constitute a significant proportion of seed trade in , and understanding cultivar performance with respect to seed quality soon after harvest is important. The objective of this study was to determine the effects of planting density and nitrogen side-dressing on crop growth, yield and seed quality. Two cultivars ( Umtata , a determinate cultivar and Kranskop, an indeterminate cultivar) were planted at three seeding rates: 5 cm, 10 cm and 15 cm within-rows and constant 75 cm between-row spacing. Two levels of N side-dressing (None and 60 kg N ha $^{-1}$) were used. Seed physical quality (purity), germination capacity and vigour (conductivity and seedling dry mass) were determined after hand-harvesting the crop. Plant growth (leaf number and plant height) and yield were significantly affected by seeding rate, but surprisingly not by N application. Seed yields were increased significantly ($P < 0.01$) by increasing planting density. The highest seeding rate ( 5cm within-rows) produced 0.1 kg m $^{-2}$; the 10 cm within-row spacing produced 0.09 kg m $^{-2}$; and the 15 cm within-row spacing produced 0.08kg m $^{-2}$. Umtata produced higher seed yield (0.1 kg m $^{-2}$) with better physical purity compared with Kranskop (0.08 kg m $^{-2}$). There was no significant effect of spacing and N application on seed germination. Germination percentages were 98% for Umtata and 92% for Kranskop. Kranskop showed a significantly better ($P<0.05$) seed vigour (2.9 g seedling $^{-1}$ dry mass) than Umtata (1.8 g seedling $^{-1}$ dry mass). This study suggests that the determinate drybean cultivar (Umtata) produces more seed yield with better physical quality than the indeterminate cultivar (Kranskop). However, future research is needed to investigate the effect of planting date on seed yield and quality under a wide range of genotypes and environments.

*Keywords:* Drybean, determinate growth, seed production, seeding rate

# LOCAL INDIGENOUS KNOWLEDGE USED AS A SEASONAL FORECAST IN THE CENTRAL FREE STATE

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Seasonal forecasting is mostly inaccessible to the majority of small-scale or subsistence farmers as a tool for better decision-making. As a result, the majority of these farmers find it very difficult to understand seasonal forecast information. Seasonal climate forecasts are issued as probabilistic outlooks for future activities, normally covering a period of 3-6 months. It is important for end-users to understand that all seasonal forecast information or data are given as probabilities. A probability forecast outlines how likely an event is to occur, as a percentage, and can assist farmers to be aware of the risks associated with weather or climate events. The high rainfall variability in the Free State and other parts of the country has led some farmers to adopt their own strategies for coping with climatic risks, which include local methods of predicting seasonal climate. This study was conducted to group and understand the needs of the farmers regarding seasonal forecasting. Most farmers rely on indigenous knowledge to make decisions on when to implement and establish agricultural activities. Indigenous knowledge has been shown to be successful to a certain degree, since farmers have been relying on it for decades. Scientific seasonal forecasting has not been utilized by many farmers, due to a lack of proper channels to disseminate such information to its end-users. Participatory techniques and tools such as workshops, focus groups, key informants, mapping, transect walk were used for data collection. The target group were resource-poor and commercial farmers. Commercial farmers with access to scientific seasonal forecasting incorporate it with traditional knowledge to make better decisions. Farmersindicated that they look at the sprouting of Aloe, shape of the moon and the time of appearance of certain types of birds and snakes, insect (ants, fireflies), cloud formations, animal behaviour such as pigs grunting, the migration of birds, patterns of stars and constellations, characteristics of plants and wind direction to help manage climate risk and forecast the onset of first rainfall, land preparation when to plant and convey other activities. The appearance of adult fireflies can be used to predict coming rains. Seasonal forecasting, whether traditional or scientific, enables the farmers to make decisions on when, what and how to plant. Farmers wait for the first rains for land preparation. Preparing land prior to the first rainfall event creates soil clods, which is not suitable for planting, but after the first rainfall the soil becomes moist enough to prepare for planting. Appropriate use of forecasting should allow farmers to reduce their risk, produce high yields and benefit economically.

*Keywords*: Seasonal forecasting, indigenous knowledge, agriculture