

# **1. THE EFFECTS OF STRATEGIC NITROGEN FERTILISER APPLICATION DURING THE COOL SEASON ON THE DRY MATTER PRODUCTION OF A PERENNIAL RYEGRASS-WHITE CLOVER PASTURE AT THE OUTENIQUA EXPERIMENTAL FARM, SOUTHERN CAPE**

**Labuschagne, J<sup>1</sup> and Gerber, H<sup>2</sup>**

*<sup>1</sup>Institute for Plant Production, Department of Agriculture Western Cape, P Bag X1, Elsenburg 7607, South Africa; <sup>2</sup>Institute for Plant Production, Outeniqua Experimental Farm, PO Box 249, George 6530, South Africa  
E-mail: johanl@elsenburg.com*

Low dry matter production of perennial ryegrass-white clover pastures during the cool seasons is of major concern. The objective of this study was to quantify dry matter yield response of a perennial ryegrass-white clover pasture to fertiliser N applied during the cool seasons.

A trial was laid out as a 5 x 3 factorial arranged in a split-plot design plus one control plot (0 kg N ha<sup>-1</sup>) per replicate. Treatment combinations were replicated four times as blocks. The main plot factor was five seasons in which N was applied between autumn and late spring and a sub-plot factor of three N levels (50, 100, or 150 kg N ha<sup>-1</sup>) applied as LAN (28). N-treatment plots (control excluded) received a single annual application of fertiliser nitrogen after cutting, the timing of application depending on season. Dry matter production was determined 5 (primary dry matter production; PDM) and 10 weeks (residual dry matter production; RDM) after fertiliser N application as well as total annual dry matter production.

On average the highest dry matter yields (kg ha<sup>-1</sup>) were obtained following fertiliser N applications in late spring N and lowest when N was applied in early winter. RDM generally increased with increasing fertiliser N rate, responses were also strongly affected by the season of fertiliser N application. The highest RDM yields were obtained when N was applied during late winter to late spring with the best yields recorded during early spring. Carry over N from the 150 kg N ha<sup>-1</sup> treatments resulted in significant higher RDM yields at the 150 kg N ha<sup>-1</sup> compared to the 100 kg N ha<sup>-1</sup> rates. Total dry matter production (PDM+RDM) were similar to PDM, the only difference, the carry over N at 150 kg N ha<sup>-1</sup> resulting in significant higher total dry matter production at the 150 kg ha<sup>-1</sup> rates in 2003 and 2005. Although the 150 kg N ha<sup>-1</sup> generally gave the best results in terms of PDM, the 50 and 100 kg N ha<sup>-1</sup> application treatments resulted in a more efficient conversion of N applied to additional DM produced.

The study revealed that fertiliser N application could be used to stimulate DM production during a predetermined period during the cooler months. Although the 150 kg N ha<sup>-1</sup> applied in late spring generally gave the best results in terms of DM produced the 50 and 100 kg N ha<sup>-1</sup> treatments resulted in a more efficient conversion of N applied to additional DM produced.

*Keywords:* dry matter production, perennial ryegrass/white clover, strategic nitrogen fertilization

## **2. THE EFFECTS OF CATTLE MANURE APPLICATION RATES AND PLACEMENT METHODS ON GROWTH AND LEAF YIELDS OF *CORCHORUS* SPECIES AND *CUCURBITA MAXIMA***

**Madakadze, RM<sup>1</sup>, Dhibhi, D<sup>2</sup> and Mugumwa, R<sup>2</sup>**

<sup>1</sup>Department of Agriculture, University of Zululand, P Bag X1001, KwaDlangezwa 3886, South Africa; <sup>2</sup>Department of Crop Science, University of Zimbabwe, P Bag MP167, Mount Pleasant, Harare, Zimbabwe  
E-mail: rmadakad@pan.uzulu.ac.za

*Corchorus* sp and *Cucurbita* sp are important traditional leafy vegetables in Southern Africa. A study was carried out at the University of Zimbabwe to determine the effects of cattle manure application rates and placement method on growth and leaf yields of *Corchorus* sp and *Cucurbita* sp. Three levels of cattle manure of 5, 10 and 20 t/ha were applied in one of three ways; broadcasting, banding and spot applications. In *Corchorus* sp plant height and leaf dry weight were significantly improved by all manure application rates with the highest attained at 20t/ha and by all manure placement methods compared to the control with the highest values obtained from the spot application method. There were significant interactions of manure application rate with placement methods on leaf area and leaf fresh weight. At 20t/ha all application methods significantly improved leaf area and fresh weight whereas at 5 and 10t/ha only the band and spot application methods significantly improved both leaf area and fresh weight. Highest fresh leaf yields of *Corchorus* sp were 11.5 t/ha attained at 20t/ha spot application method.

In *Cucurbita* sp there were significant interactions of application rate and placement methods on all parameters. Vine length, leaf area, leaf fresh weight, leaf numbers and branch numbers generally increased with an increase in cattle manure application rate as well as manure placement method from broadcasting, band and spot. Five tonnes per hectare cattle manure at all application methods had no effect on leaf and branch numbers compared to the control. In both crops at 20t/ha placement method used was not very important but when the cattle manure application rate was low banding and spot applications were more effective in improving growth and fresh leaf yields.

*Keywords:* *Corchorus* sp, *Cucurbita* sp, leaf yields, cattle manure, placement method

### **3. RESIDUAL EFFECTS OF PHOSPHORUS AND POTASSIUM FERTILISER ON FOLIAR, FOREST FLOOR AND SOIL NUTRIENT CONTENT OF A FIVE-YEAR-OLD SUCCESSIVE *PINUS PATULA* CROP IN SWAZILAND**

**Crous, JW<sup>1</sup>, Morris, AR<sup>2</sup> and Scholes, MC<sup>3</sup>**

<sup>1</sup>*Sappi Forests Research, PO Box 372, Ngodwana 1209, South Africa;* <sup>2</sup>*Sappi Forests (Pty) Ltd, PO Box 473, Howick 3290, South Africa;* <sup>3</sup>*School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, P Bag X3, Wits 2050, South Africa*

*E-mail: jacob.crous@sappi.com*

The sustained production from successive rotations of *Pinus patula* has been an active research focus for nearly fifty years on the Usutu plantation. On part of the plantation, underlain by gabbro rocks, a 20% growth decline was reported between first and second rotations. This was caused by developing potassium (K) and phosphorus (P) deficiencies. The application of 75 kg ha<sup>-1</sup> P and K fertiliser respectively corrected the decline in yield. In 1989 a trial was established in a third rotation crop to determine the residual effects of the operational fertiliser application in the following rotation. During September 1999 a PK factorial treatment combination was applied to the fourth rotation with the residual PK effect occurring as a split plot treatment. In 2004 intensive soil, foliar and forest floor sampling was conducted in the trial.

At the age of five years data from 12 intensively sampled plots indicated that the residual fertiliser increased the mass of the humus and forest-floor-to-soil transition layer by 3.5 t ha<sup>-1</sup>. P concentrations in the live foliage, litter fall, forest floor and topsoil also increased as a result of the residual fertiliser. Fifteen years after the initial fertiliser application there was still higher levels of exchangeable K per hectare in the forest-floor-to-soil transition layer. We conclude that more residual P fertiliser remained available to the subsequent crop than residual K fertiliser. However, fertiliser applications to successive crops can be adjusted to provide for benefit from the residual fertiliser.

*Keywords:* residual fertiliser, phosphorus, potassium

#### **4. EFFECTS OF FERTILISER AND MANURE PRACTICES ON SOIL ORGANIC CARBON, NITRATE, PHOSPHORUS, pH AND ELECTRICAL CONDUCTIVITY**

**Seobi, T**

*North West Department of Agriculture, Conservation and Environment, P Bag X804,  
Potchefstroom, 2520, South Africa  
E-mail: tshepiso@potch1.agric.za*

The rural poor farmers are not applying fertiliser according to crop nutrient needs and soil fertility status. A considerable proportion of these farmers cannot afford purchasing sufficient amount of fertiliser. A trial was established in summer of 1997, and the no fertiliser control, fertiliser application according to custom in the locality [75 kg ha<sup>-1</sup> 3:2:1 (25)], fertiliser application according to fertiliser recommendation from soil analysis [125 kg ha<sup>-1</sup> 2:1:0 (30)], ten ton (fresh matter basis) cattle manure application, and combination of five ton manure plus half fertiliser recommendation, were the tested yearly treatments. Rainfed maize was produced in Ditsobotla, near Lichtenburg, with long-term average rainfall of about 500 mm per year. The area lay fallow for more than three years before start of the trial. Average maize grain yield was 2.34 t ha<sup>-1</sup> across all five treatments in winter 1998 (P>0.05). In 1999, manure, combination and custom fertiliser treatments yielded slightly higher (17%), while recommended fertiliser treatment yielded 49% higher than the control treatment (1.48 t ha<sup>-1</sup>). In 2000, all other four treatments yielded 73% higher than the control treatment (1.45 t ha<sup>-1</sup>).

Soil samples were taken in trial plots during harvesting and planting in 1999 (June and November, respectively) and in 2000 (July and October). In 1999, first year of sampling, manure treatment had higher electrical conductivity (EC; 44.1 mS m<sup>-1</sup>) than the control and custom fertiliser treatments (with averages of 27.8 mS m<sup>-1</sup>). The third harvest year was 2000.

In 1999, soil nitrate during planting (November) was higher than during harvesting (June; 9.05 against 4.10 mg kg<sup>-1</sup>). The same trends happened for both soil nitrate (3.05 versus 2.53 mg kg<sup>-1</sup>) and P (10 versus 6 mg kg<sup>-1</sup>) in 2000. It is thus important to measure soil nitrate and P during planting for best fertiliser recommendations. Manure treatment lowers required fertiliser nitrogen (N) and P, and alleviates soil acidity.

*Keywords:* Manure, Custom fertiliser practice, Soil pH, Soil electrical conductivity, Maize

## **5. FACTORS LIMITING PRODUCTIVITY OF SMALL-SCALE MAIZE-BASED IRRIGATION SCHEMES – A CASE STUDY OF ZANYOKWE IRRIGATION SCHEME, EASTERN CAPE**

**Fanadzo, M, Chiduza, C, Mnkeni, P and Muchaonyerwa, P**

*Department of Agronomy, University of Fort Hare, P Bag X1314, Alice 5700,  
South Africa*

*E-mail: mfanadzo@ufh.ac.za*

There is general agreement in irrigation literature that small-scale irrigation schemes in South Africa have performed below expectations with regards to improving incomes and sustaining rural livelihoods of small-scale farmers. The Water Research Commission is funding the Best Management Practices in Smallholder Irrigation project in Eastern Cape and KwaZulu-Natal provinces with the objective of developing and implementing technologies and knowledge useful for small-scale farmers in order to improve rural livelihoods. A situation analysis conducted in Zanyokwe in 2005 revealed some of the underlying constraints responsible for low productivity. Further diagnosis of the problem of low crop productivity was continued in the scheme in the 2005/06 season using two strategies, the conduct of exploratory trials and monitoring of farmer agronomic practices. Both strategies had a common objective of identifying and quantifying the agronomic factors limiting crop productivity. Two on-farm trials were carried out, a comparison of yield of new hybrids to varieties grown by farmers and an evaluation of the interaction between variety, nitrogen fertilisation, plant population and planting time on maize productivity. A sample of 43% of farmers, stratified into three wealth ranks was monitored throughout the 2005/06 season. Results of the variety evaluation showed that new hybrids could yield as high as 10t/ha with early December planting but farmer preference was for SC701 and Okavango which yielded 50 to 65% lower. These varieties are preferred for corn cob. An exploratory showed a significant two way interaction of planting date and plant population. Monitoring showed that poor weed, water and fertiliser management tended to limit crop productivity. The average cropping intensity was 43.3%. As a result of preliminary work a research program focusing on weed and fertiliser management was designed. These preliminary results suggest the lack of viability of small-scale schemes is partly a result of inappropriate agronomic practices for crop production. These have to be taken into consideration in the ongoing exercise of revitalising small-scale schemes in the Eastern Cape Province by the Department of Agriculture.

*Keywords:* small-scale, low productivity, constraints, yields

## **6. EFFECT OF PLANTING DATE, PLANT DENSITY AND CULTIVARS ON YIELD AND YIELD COMPONENTS OF SHORT AND ULTRA-SHORT GROWTH PERIOD MAIZE CULTIVARS AT TWO SELECTED AREAS OF THE “MAIZE TRIANGLE” OF SOUTH AFRICA**

**Kgasago, H<sup>1</sup>, Reinhardt, CF<sup>2</sup>, Maali, SH<sup>1</sup> and Steyn, JM<sup>2</sup>**

*<sup>1</sup>ARC-Grain Crops Institute, P Bag X1251, Potchefstroom 2520, South Africa;*

*<sup>2</sup>Department of Plant Production and Soil Science, Faculty of Natural and Agricultural Sciences, University of Pretoria, Pretoria 0002, South Africa*

*E-mail: kgasagoh@arc.agric.za*

The short growing season maize cultivars, which have been developed recently, can address the problem of lower production, which is attributed to traditional mid-summer drought due to poor weather conditions. Moreover, plant density also becomes a limiting factor for maize yield. There is no single rule for all conditions because the optimum plant density is dependant on all unmanageable environmental factors and manageable factors such as maize cultivars selection and planting date. There have been little or no previous studies to evaluate the effects of planting dates and plant densities on short and ultra short growth period maize cultivars. This prompted this study, which is started in the 2004/05 season. A study was conducted to evaluate the effect of planting dates, plant densities and cultivars on yield and yield components of short and ultra-short growth period maize cultivars. One field experiment was conducted at each of two selected sites (Bethlehem & Potchefstroom) in the “Maize Triangle of South Africa”. Treatments used were three planting dates, three planting densities and four cultivars and one open-pollinated variety.

The following yield and yield components were measured; cob numbers, cob mass, 100 kernel mass, cob length, kernel number per cob and grain yield. Yield and yield components were significantly affected by planting dates, plant densities and cultivars at both localities. At both localities early and optimum planting dates as well as low and optimum plant densities promoted increases in yield components, which contributed to increase in grain yield. As for the cultivars, PAN6017 proved to be the most consistent since it out-performed other cultivars in terms of yield components and grain yield at both localities.

In order to make findings of a study such as this applicable to “Maize Triangle of South Africa”, more research on short and ultra-short growth period maize cultivars should be conducted over a wider range of locations and seasons.

*Keywords:* Cultivars, grain yield, yield components, planting date, plant density

## **7. THE PRODUCTION OF MAIZE UNDER IRRIGATION AT LOWER PLANT POPULATION IS LESS PROFITABLE**

**Coetzee, AS**

*PO Box 47, Douglas 8730, South Africa  
E-mail: a.coetzee@gwk.co.za*

The most maize varieties (short growers) are planted under irrigation in the Northern Cape at a population of 80000-90000 plants/ha. Lower maize prizes and high seed prizes led to planting a trial to see what the profits could be by reducing the plant populations of a few varieties. The objective was to see if maize varieties (PAN 6126, PHB 32D96B, PHB 31N16, AFG 4410 and DKC 78-15B) planted at rates of 85000, 60000 and 40000 kernels/ha could achieve the same or better profits at lower plant population.

Each variety was planted at the different population rates. Each variety for the different rates was planted with a four row planter for 250 m. The row width was 76 cm. The production practices of the farmer were used. The trial was planted under centre pivot irrigation as part of the farmer's normal maize crop. Each plot (250 m x 4 rows x 0.76 m) was harvested separately and weighed. The moisture content of each plot was measured. The yields were calculated at a moisture content of 12.5%. A standard production cost of R7200 per ha (seed price = R1300/85000 kernels) and maize price of R950 per ha was used. Seed price of 85 000 kernels/ha: PAN 6126 = R1300, PHB 32D96B=R1300, PHB 31N16=R1100, AFG 4410=R900 and DKC 78-15B=R1200, was used. The data showed that all varieties planted at 85 000 plants per hectare was the best population for highest profit and all the varieties at planted at 40 000 plants per ha made the lowest profit. The trial proved that it is less profitable to plant maize varieties at lower population rates if the price of maize is R950 per ton or higher.

*Keywords:* Maize varieties, population rates, profit

## **8. GROWTH TEMPERATURE AND PHOSPHORUS NUTRITION EFFECTS ON SEED PERFORMANCE IN MAIZE**

**Asanzi, NM and Modi, AT**

*Department of Crop Science, University of KwaZulu-Natal, P Bag X01, Scottsville,  
Pietermaritzburg 3209, South Africa  
Email: mnafabuanga@yahoo.fr*

The aim of the study was to determine the effect of day/night temperatures (22/16°C, 27/21°C and 33/27°C) and phosphorus levels (0, 0.12g and 1.2 g per 20 kg soil) on seedling establishment and seed viability during three stages of development (15, 22 and 33 days after flowering). Soluble carbohydrate accumulation was examined in relation to seed phytate levels and seed germination capacity at different stages of development. Leaf emergence and plant height were significantly influenced ( $P < 0.05$ ) by temperature and phosphorus nutrition. Phosphorus and temperature also caused a significant increase ( $P < 0.05$ ) in seed germination at all stages of development. The normal maize showed significantly ( $P < 0.05$ ) higher germination and mineral element content than the quality protein maize. Soluble carbohydrate determination is in progress. Preliminary findings showed that phosphorus nutrition increases seed phytate and seed germination in maize.

*Keywords:* Temperature, Phosphorus nutrition, Phytate content



## 9. CITRUS PRODUCTION IN FLORIDA (USA)

**Davies, FS**

*Department of Horticultural Sciences, University of Florida, Gainesville, Florida 32611,  
USA*

*E-mail: fsd@mail.ifas.ufl.edu*

Citrus fruits were brought to north Florida by the Spanish in the late 1500s. Citrus production has continued to move southward in the peninsula due to severe freezes of the 1980s. Most commercial citrus is grown between latitudes 25° and 29° N. Currently, citrus is grown on about 250,000 ha with an estimated production of 7.4 MMT for 2006-2007. Planted ha and production are down considerably from highs of 380,000 ha and 13.6 MMT, respectively, due to hurricanes, citrus canker, and urbanization. More than 90% of Florida's citrus is processed into juice, although considerable amounts of fresh grapefruit and mandarins are produced. 'Hamlin' (early) and 'Valencia' (late) are the most important orange cultivars, and 'Ruby Red', 'Flame', 'Star Ruby', and 'Marsh' are the major grapefruit cultivars. New orange cultivars are being tested and several mandarins and mandarin-hybrids including 'Sunburst' and 'Robinson' are grown primarily for fresh fruit. Swingle citrumelo and Carrizo citrange continue to be the major rootstocks, but several new selections are being tested with improved tolerance to adverse soil conditions, and Diaprepes root weevil. Production emphasis is on Best Management Practices (BMPs) for nutrient and water management and the development of improved mechanical harvesting systems. Harvesting labor has been at a premium in recent years. Citrus tristeza virus, blight, and phytophthora continue to be significant disease problems and mites, psyllids, citrus leafminer and weevils are important pest problems. Currently, however, canker combined with citrus leafminer, and greening are the major concerns of Florida citrus growers. In addition, hurricanes in 2004 reduced orange and grapefruit production by 23 and 63%, respectively and spread canker extensively throughout the state. As a result of these problems the citrus nursery industry is shifting to greenhouse production in isolated areas. Despite these problems, the Florida citrus industry remains resilient and competitive. In the future, it is likely that the Florida citrus industry will be smaller, more efficient and more tightly regulated.

*Keywords: Citrus sinensis, Florida, citrus production*

## 10. VEGETATIVE GROWTH RESPONSES OF CITRUS NURSERY TREES TO VARIOUS GROWTH RETARDANTS

Barry, GH<sup>1</sup> and Le Roux, S<sup>2</sup>

<sup>1</sup>*Citrus Research International, Department of Horticultural Science, Stellenbosch University, P Bag X1, Matieland 7602;* <sup>2</sup>*Department of Horticultural Science, Stellenbosch University, P Bag X1, Matieland 7602, South Africa*  
E-mail: gbarry@sun.ac.za

As part of a larger study to improve rind colour of citrus fruit, an ancillary study was conducted to determine the concentration of various gibberellin biosynthesis inhibitors required to get a biological response in citrus trees, as measured by vegetative growth. Repeated foliar applications of ProGibb® (4% v/v GA<sub>3</sub>) increased growth of 'Eureka' lemon (*Citrus limon*) shoots by 63%, with no significant effect on rootstock and scion diameters. Repeated applications of Regalis® (10% v/v prohexadione calcium) at various concentrations (1, 2, 4 and 8 g·L<sup>-1</sup>) as well as Sunny® (5% v/v uniconazole) (at 10 and 20 mL·L<sup>-1</sup>) and Cultar® (25% v/v paclobutrazol) (at 10 mL·L<sup>-1</sup>) had no effect on the rootstock or scion diameters 8 months after the first application. Both the 4 and 8 g·L<sup>-1</sup> Regalis® treatments, both Sunny® treatments and the Cultar® treatment significantly reduced shoot growth. Sunny® at 20 mL·L<sup>-1</sup> resulted in the most growth retardation which resulted in 34% shorter shoot length than the control. Although the number of nodes on the longest shoot did not differ from the untreated control, internode length differed significantly among treatments. Regalis® at 4 and 8 g·L<sup>-1</sup>, Sunny® at 20 mL·L<sup>-1</sup> and Cultar® at 10 mL·L<sup>-1</sup> reduced internode length relative to the control by 31%, 56%, 50% and 28%, respectively.

**Keywords:** Citrus, Vegetative growth, Growth retardants

## **11. THE USE OF HOT WATER AND MOLYBDENUM DIP TREATMENTS FOR REDUCTION OF CHILLING INJURY ON LEMONS**

**Bower, JP and Mathaba, N**

*Horticultural Science, University of KwaZulu-Natal, P Bag X01, Scottsville,  
Pietermaritzburg 3209, South Africa  
E-mail: bowerj@ukzn.ac.za*

Citrus in general, and the lemon (*Citrus limon* Burm.f) in particular, are considered to be chilling sensitive, with long periods of storage at low temperature resulting in rind breakdown. In the past, shipping temperatures to take account of this have been used. However, many of the market opportunities for South African producers have phytosanitary restrictions which require cold sterilization at temperatures in some cases below zero, for as long as 22 days. Under these conditions, the risk of chilling injury is high. Treatments to decrease the potential for chilling injury are thus urgently required. In the case of other citrus such as sweet oranges, a hot water dip treatment has been found to be beneficial, although the potential for hot water damage is also substantial. Little information is presently available for such a treatment on lemons. Commercially available lemon fruit was treated in hot water at 47°C and 53°C for 2 minutes before waxing and storage at -0.5°C for 30 days. Additionally, fruit subjected to the same treatments had 1, 5 or 10 µmol molybdenum added to the dip, as other work indicated that this compound decreased the potential for hot water damage. Commercially waxed and untreated fruit served as the control. On removal of fruit from storage, no chilling injury symptoms were seen. However, after 4 days, the control fruit showed significantly higher chilling injury than those hot water treated. Further, the molybdenum dip treatment had an additional effect, with fruit treated with 5 and 10 µmol molybdenum at 47°C and the 1 and 5 µmol molybdenum at 53°C showing no chilling injury. The mode of action pertaining to molybdenum is presently unknown, and further research will be necessary. Nevertheless, it is suggested that the treatments will be useful as mitigating treatments for chilling injury in cold sterilized lemons.

*Keywords:* Lemons, Chilling injury, Hot water treatment

## **12. THE ENVIRONMENTAL IMPACT OF LARGE-SCALE IRRIGATION WITH MINE-WATER ON SOIL AND WATER RESOURCES**

**Annandale, JG<sup>1</sup>, Beletse, YG<sup>1</sup>, De Jager, C<sup>1</sup>, Usher, BH<sup>2</sup>, Coleman, TJ<sup>3</sup> and Du Plessis, HM<sup>4</sup>**

*<sup>1</sup>Dept. Plant Production and Soil Science, University of Pretoria, Pretoria 0002, South Africa; <sup>2</sup>Institute for Groundwater Studies, University of the Free State, Bloemfontein 9300, South Africa; <sup>3</sup>Golder Associates, South Africa; <sup>4</sup>Water Research Commission, P Bag X03, Gezina, Pretoria 0031, South Africa  
E-mail: john.annandale@up.ac.za*

Irrigation of agricultural crops is one of the most cost effective options for the utilization of calcium and magnesium sulphate rich mine wastewaters. Gypsum is a slightly soluble salt and concentrating gypsiferous soil solutions through crop evapotranspiration precipitates gypsum in soil, removing it from the water system and reducing the potential for pollution of water resources. However, not all salts applied to the field in the irrigation water precipitate, and leaching of soluble salts is essential for the sustainability of irrigation.

Field trials were carried out in South Africa on three mines: Kleinkopje and New Vaal Collieries (Anglo Coal), and at Syferfontein (Sasol). Different crop and pasture species were grown on different soil types under centre pivot irrigation with different mine-water qualities. Intensive monitoring systems were established in each irrigated field to determine the components of the soil water and salt balance. Boreholes were also installed to monitor groundwater level and quality. Field water and salt balance data were used for calibration and validation of the mechanistic, generic crop, Soil Water Balance (SWB) model.

The results of the field trials indicated that high crop and pasture yields are attainable, provided site selection, land preparation, fertilization and irrigation water management are appropriate. The results of the soil water and salt balance studies indicate that considerable volumes of mine-water can be used and substantial amounts of salts can be removed from the water system through precipitation of gypsum in the soil profile. With appropriate management, water and salt runoff, and under specific conditions, drainage and salts leached can be intercepted, thereby minimizing unwanted impacts on groundwater. Thirty-year scenario simulations were run with SWB and the generated salt loads from this model were used as input into a separate surface water model, the Water Resources Planning Model (WRPM), and into a groundwater model in order to predict the likely long-term effects of irrigation with mine-water on groundwater and the broader receiving surface water environment.

The results of these simulations showed that while salts reached the groundwater, there was a drop in concentration of the plume as it moved away from the irrigated area. This was due largely to dilution by infiltration from rainfall recharge and the dispersive characteristics of the aquifer. The simulations also showed the importance of matching the amount of drainage from an irrigated site with the transmissivity and storage properties of the aquifer below. These results suggest that large-scale irrigation with gypsiferous water could be viable if irrigated fields are carefully sited to prevent waterlogging and are well managed.

*Keywords:* Mine-water, SWB, surface water, groundwater

### **13. OXIDATIVE BREAKDOWN OF POLYCYCLIC AROMATIC HYDROCARBONS BY MANGANESE OXIDE TAILINGS**

**Dowding, CE<sup>1</sup>, Johnson, KL<sup>1</sup> and Hutchings, T<sup>2</sup>**

<sup>1</sup>*School of Engineering, South Rd, Durham DH13 LE, UK;* <sup>2</sup>*Forest Research, Alice Holt Lodge, Farnham, Surrey GU10 4LH, UK*  
*E-mail: catherine.dowding@durham.ac.uk*

The Kalahari Manganese Field situated in the Northern Cape province of South Africa represents the largest body of Mn ore in the world holding up to 80% of the world's Mn reserves. As a result of ore extraction processes large quantities of fine, relatively pure Mn oxide tailings are generated. Despite being classified as a 'waste' the tailings material could be a valuable source of 'slow-release' oxidising capacity for the treatment of organically contaminated soils. Manganese oxides are one of the most powerful oxidants in terrestrial geochemical systems. They are involved in redox cycles in soils and waters, which are essential to nutrient cycling, humification, contaminant fate and mobility. Oxidation is a common technique used in soil and water remediation, but requires the use of expensive oxidising agents such as peroxide and permanganate. These unsustainable oxidising techniques are often not successful in soils due to the hydroxyl radicals being scavenged by natural organic matter before the target compound can be oxidised. Thus the Mn oxide tailings may provide a suitable source of 'slow-release' oxidative capacity for the remediation of organically contaminated soils and waters.

The tailings materials are fine (<200 µm), highly crystalline and have a low surface area (1.2-6.4 m<sup>2</sup>/g). The total Mn content varies between 33 and 42%. The mineralogy consists of Mn(III/IV) oxides (birnessite, manganite, hausmannite); mixed Mn and Fe oxides (bixbyite, galaxite); a Mn(III) silicate (braunite) and various carbonates (calcite and barite). The material is alkaline and well buffered due to the large carbonate fraction. Despite the high crystallinity of the material there appears to be a large pool of hydroquinone-reducible Mn (2-3 wt%), which would suggest the tailings contain an 'easily' reducible and reactive phase.

Polycyclic Aromatic Hydrocarbons (PAHs) are ubiquitous contaminants which appear to resist bioremediation techniques, largely due to their very low water solubility, and thus persist in soils and waters. There have been limited studies conducted on oxidation and degradation of PAHs by Mn oxides. In this study the Mn oxide tailings materials were reacted with anthracene, one of 16 PAHs appearing on the USEPA priority contaminant list. The preliminary results obtained using UV-visible spectrometry and gas chromatography mass spectrometry show anthracene is being oxidised to anthraquinone on the surface of the tailings material. This represents one of the first observations of anthracene oxidation by Mn oxides.

*Keywords:* Free Radicals, Manganese oxide, PAHs

## **14. DYNAMICS OF VANADIUM IN SOILS AND GRASS AROUND A VANADIUM PROCESSING PLANT**

**Kirsten, WFA<sup>1</sup> and Gummow, B<sup>2</sup>**

<sup>1</sup>*ARC-Institute for Soil, Climate and Water, P Bag X79, Pretoria 0001, South Africa;*

<sup>2</sup>*Faculty of Veterinary Science, University of Pretoria, P Bag X04, Onderstepoort 0110, South Africa*

*E-mail: willem@arc.agric.za*

South Africa is the world's largest producer of vanadium. Vanadium pollution and human and animal health around vanadium-producing plants have become key issues. The main pollutants from such plants are vanadium pentoxide, ammonium vanadate and sodium and ammonium sulphate, all of which are water soluble. Monitoring of vanadium fallout from a new processing plant in the North West Province commenced in 1999 and is still ongoing. The purpose of the monitoring was to study the dynamics of vanadium around a processing plant. Six camps were fenced off around the plant: two high exposure camps close to the plant and four low exposure camps approximately three kilometres away. A herd of cattle was kept in each area. Five transects with three monitoring points each were measured out from the plant outwards. Fallout buckets on each monitoring point were replaced monthly and grass as well as soil samples were collected around each sampling point. Two grass species, namely *Themeda triandra* and *Panicum maximum*, were sampled. The water soluble vanadium, sodium, sulphate and ammonia were measured in the fallout and NH<sub>4</sub>-EDTA-extractable vanadium as well as EPA 3050-digestible vanadium were measured in the soil. Washed and unwashed grass samples were analysed. The grass samples were dried, milled and digested with a microwave-assisted digestion procedure and analysed for vanadium content. The data was analysed statistically. No significant increase in NH<sub>4</sub>-EDTA-extractable vanadium from the soils could be detected. The vanadium content in grasses increased on a dry matter basis during the growing season.

*Keywords:* Vanadium, soils, grass

## **15. DETERMINATION OF SEEPAGE LOADS FOR A FERROCHROME SMELTER SITE**

**Van Zyl, AJ, Bezuidenhout, N and Brown, SAP**

*Golder Associates Africa (Pty) Ltd., PO Box 6001, Halfway House 1685, South Africa  
E-mail: avanzyl@golder.co.za*

Modelling of the seepage loads (volume and quality) from the waste disposal facilities was necessary to refine the understanding of cause and effect relationships between waste sites and groundwater. Waste classification was done according to the Department of Water Affairs' Minimum Requirements for the Handling and Disposal of Hazardous Waste to prioritise the waste facilities in terms of the hexavalent chromium waste loads. A number of test pit observations, field measurements, sampling of wastes, soils and underlying geological material, as well as geochemical and geotechnical analyses were conducted to provide detailed data for the specialists modelling of seepage quantities and qualities. The Vadoze/W unsaturated flow model was used to model likely seepage quantities from priority waste facilities by taking account of waste and site-specific parameters. The likely seepage qualities from the priority waste facilities were determined from the geochemical characterisation and likely water contents of the wastes and soils. The predicted hexavalent chromium seepage loads indicate that a high priority should be given to waste facilities containing bag filter dust and sludge in the remediation action. A notable mass of hexavalent chromium is still available for future leaching at all the priority waste facilities. The results from this study were used to 1) prioritise the waste facilities in terms of Cr<sup>6+</sup> seepage loads, 2) define the historic and future temporal distribution of seepage and waste loads, 3) confirm the results of the calibrated groundwater model for the site, and 4) recommend source-directed remediation measures.

*Keywords:* Hexavalent chromium, Seepage loads

## **16. POSSIBLE CAUSES AND MEASURES TO PREVENT EXCESSIVE LEAF ABSCISSION IN THE AVOCADO (*PERSEA AMERICANA* MILL.) CULTIVAR RYAN**

**Roets, NJR<sup>1</sup>, De Meillon, S<sup>2</sup>, Kaiser, C, Robbertse, PJ<sup>3</sup>, Owen, R<sup>4</sup> and Ehlers, R<sup>4</sup>**

<sup>1</sup>*ARC-Institute for Tropical and Subtropical Crops, P Bag X11208, Nelspruit 1200;*

<sup>2</sup>*Department of Botany, University of Pretoria, Pretoria 0002;* <sup>3</sup>*Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002;* <sup>4</sup>*Department of Statistics, University of Pretoria, Pretoria 0002, South Africa*

*E-mail: nico@arc.agric.za*

The avocado cultivar Ryan is important in the South African avocado industry as it comes into production late (July to August) and therefore extends the avocado production period. However, excessive leaf abscission during flowering on 'Ryan' has a negative effect on fruit set and production. This is because fruit set and early fruit growth depends mainly on photosynthates from the leaves. Stress factors, such as drought, unfavourable climatic conditions and nutrient imbalances can contribute to this problem. The aim of the study was to determine the possible factors causing leaf abscission in 'Ryan' and to apply treatments to reduce leaf abscission. The possible factors influencing leaf abscission were investigated in a trial laid out in a random block design. Leaf samples for nutrient analysis and bark samples for starch analysis were collected at six different phenological stages for the cultivars Fuerte, Hass and Ryan. Leaf area, flowering intensity and leaf chlorophyll content were also measured for all three cultivars at the same six phenological stages. All these factors were correlated with leaf abscission and compared for all cultivars. Due to the high rainfall the effect of water stress could not be investigated. In addition, applications of plant growth regulators and the reflective substance, Kaolin, were made in an attempt to reduce leaf abscission on 'Ryan'. Plant growth regulators used were NAA at 30mg/L, Kelpak<sup>®</sup> (0.031mg/L cytokinins and 11mg/L auxins) at 5mL/L, Ethapon<sup>®</sup> at 250mg/L, and GA<sub>3</sub> at 50mg/L. The kaolin application was done at 3% concentration. Applications were done at two phenological stages, when buds were dormant, and when buds started to swell. During the dormant bud stage an additional application of 0.5% LB urea was also made. Leaf abscission and fruit set were monitored. The results will be discussed.

*Keywords: Persea americana* Mill., leaf abscission, nutrients, starch, plant growth regulators, kaolin



## **17. STEM WATER POTENTIAL AS A MEASURE OF PLANT WATER STATUS IN CITRUS TREES (*CITRUS* SPP.)**

**Barry, GH<sup>1</sup> and Prinsloo, JA<sup>2</sup>**

<sup>1</sup>*Citrus Research International, Department of Horticultural Science, Stellenbosch University, P Bag X1, Matieland 7602;* <sup>2</sup>*Department of Horticultural Science, Stellenbosch University, P Bag X1, Matieland 7602, South Africa*  
*E-mail: gbarry@sun.ac.za*

As part of a larger study to quantify the effects of daily fertigation on ecophysiological responses in citrus trees (*Citrus* spp.), initial research was conducted to optimise and standardise the sampling procedure to quantify stem water potential ( $\psi_{\text{stem}}$ ) in citrus trees. Bagging of leaves with black polyethylene envelopes a few hours prior to measuring  $\psi_{\text{stem}}$  allows the plant water status in those leaves to equilibrate with whole-tree plant water status, thereby providing a realistic measurement of the current water status. The use of aluminium foil to cover the bagged leaves, reduces unwanted heat stress by reflecting sunlight, and dramatically reduced variation in  $\psi_{\text{stem}}$ . The time of day at which  $\psi_{\text{stem}}$  measurements are made is important to ensure consistency in comparisons among treatments and interpretation of irrigation treatment effects. “Physiological midday” is the preferred time of day to measure  $\psi_{\text{stem}}$ , i.e. 1100 HR. Transpiring leaves with open stomata would be in sun-exposed positions on the east side of trees and should be used for making  $\psi_{\text{stem}}$  measurements. Under similar experimental conditions as those used here, only three leaves per replicate are required to detect a difference of 0.05 MPa in  $\psi_{\text{stem}}$  between treatment means.

*Keywords:* Citrus, Stem water potential

## **18. EFFECT OF BIOLOGICAL SOIL AMENDMENTS ON TREE GROWTH AND MICROBIAL ACTIVITY IN NEWLY ESTABLISHED POME FRUIT ORCHARDS**

**Van Schoor, L<sup>1</sup>, Stassen, PJC<sup>2</sup> and Botha, A<sup>3</sup>**

*<sup>1</sup>ARC-Infruitec-Nietvoorbij, P Bag X5026, Stellenbosch 7599; <sup>2</sup>Dept. Horticultural Science, University of Stellenbosch, P Bag X1, Matieland 7602; <sup>3</sup>Dept. Microbiology, University of Stellenbosch, P Bag X1, Matieland 7602, South Africa  
E-mail: vschoorl@arc.agric.za*

Deciduous fruit production is demanding more sustainable production practices due to the adverse effect of conventional practices on soil biological activity and diversity. Efficient soil microbial functioning is critical in all agricultural systems and negative effects on the soil microbial community can lead to poor root development and nutrient uptake, ultimately affecting growth and yield negatively. Soil rehabilitation and root growth stimulation is of prime importance in orchards with apple replant disease (ARD). We hypothesised that the application of organic matter, soil microbial inoculants and biostimulants can improve soil microbial activity and feeder root development, thereby having a positive effect on tree growth in newly established orchards, especially ARD sites.

The objective of this study was firstly, to evaluate the potential use of various biological soil amendments for use in pome fruit production and specifically for use in replant disease sites as a viable alternative for ARD control. Furthermore, the effect of the treatments on soil microbial community activity was examined, using soil enzyme assays, community level physiological profiles (CLPP) and conventional microbial plate counts. Lastly, an attempt was made to establish if changes in microbial activity as measured through these methods could be used as indicators of tree performance, in terms of growth of young trees. After three seasons of biological amendment application at two sites, amendments that performed the best in terms of growth increase were compost in combination with compost extract and application of beneficial bacteria (Biostart®). However, results from ARD trials were less significant and methyl bromide fumigation was still the best treatment. Soil enzyme assays showed significant changes in soil microbial activity with fumigated soil showing lower activity while compost extract amended soil, as well as Biostart® amended soils showed higher activity. No simple relationship could be identified between tree performance and soil microbial activity through the various methods used.

*Keywords:* apple replant disease, compost, compost extract, enzyme activity

## **19. SEASONAL CHANGES IN CONTENTS OF ANTIOXIDANT COMPOUNDS IN 'HASS' AVOCADO**

**Tesfay, SZ and Bertling, I**

*Horticultural Science, University of KwaZulu-Natal, P Bag X01, Scottsville,  
Pietermaritzburg 3209, South Africa  
E-mail: 20150442@ukzn.ac.za*

The interest in the content of antioxidant compounds of avocado fruit has become increasing due to their potential in mitigating photo-oxidative injury to the whole plant system, but fruit in particular. Various antioxidant systems were found to be present in avocado. To study the potential production of enzymatic and non-enzymatic antioxidants of 'Hass' avocado, fruit were collected from an orchard and analysed for antioxidants. Fluctuations in total concentrations of ascorbic acid, anthocyanin, antioxidant and soluble sugars in these organs are reported and the possible relationship of the systems discussed.

*Keywords:* avocado, antioxidants

## **20. POTENTIAL AND ACTUAL SOIL LOSS PREDICTION MAPS FOR SOUTH AFRICA**

**Le Roux, JJ, Morgenthal, TL, Malherbe, J, Smith, HJ, Newby, TS and Weepener, HL**

*ARC-Institute for Soil, Climate and Water, P Bag X79, Pretoria 0001, South Africa  
E-mail: lerouxj@arc.agric.za*

Previous research indicates that more than 70% of South Africa (SA) is affected by varying intensities of soil erosion. Given the increasing threat of soil erosion a need for research was identified by the national Department of Agriculture to improve techniques of estimating the soil erosion risk at a national level. This study anticipates the refinement of regional soil loss modelling techniques for SA within a GIS framework. Indicators of erosion susceptibility of the physical environment, including climate erosivity, soil erodibility and topography, were improved by feeding current available data into advanced algorithms. These indicators were combined to create a soil loss potential map of SA, which represents the inherent susceptibility of the soil to rainfall erosion, irrespective of vegetation cover or land use. Areas with a high erosion potential occur mostly in the eastern parts of SA, especially along the eastern marginal zone (approximately 42 million ha) positioned between the interior plateau and the coast (0-1200 m a.s.l.). In total, almost 50% of land has a moderate to severe erosion potential (>12 t/ha/yr), especially areas associated with pronounced relief and high erodibility.

Actual soil erosion risk, which relates to the current risk of erosion under present vegetation and land use conditions, was estimated by means of satellite imagery (MODIS instead of NOAA) and the National Land Cover Map of SA. Approximately 20% of land is classified as having a moderate to severe actual erosion risk. Comparison of the potential and actual erosion risk indicates a strong inverse relationship with vegetation cover and reflects the protective influence provided by present land cover. Over 26 million ha (30% of national land) would be subject to high erosion risk without protection of the current vegetation cover and land use.

*Keywords:* Soil erosion, modelling, national scale

## **21. STREAM FLOW AS ESTIMATED BY AUTOMATED GEOSPATIAL WATERSHED ASSESSMENT (AGWA) TOOL IN THE UPPER OLIFANTS CATCHMENT AREA**

**Phahlane, MO<sup>1</sup>, Du Pisani, AL<sup>1</sup>, Le Roux, JJ<sup>1</sup>, Germishuise, T<sup>1</sup> and Walker, S<sup>2</sup>**

*<sup>1</sup>ARC-Institute for Soil, Climate and Water, P Bag X79, Pretoria 0001, South Africa;*

*<sup>2</sup>Department of Soil, Crop and Climate Sciences, University of the Free State, PO Box 339, Bloemfontein 9300, South Africa*

*E-mail: phahlane@arc.agric.za*

The Olifants River is a very important natural resource in Mpumalanga Province as mining, tourism and agriculture depend largely on the consistent water flow in the river. The Automated Geospatial Watershed Assessment (AGWA) model is a GIS-based hydrological modelling tool that is available as an extension for ArcView 3.2a. AGWA is designed to facilitate the assessment of land use and climate change impacts on water yield and quality at multiple scales. The Soil and Water Assessment Tool (SWAT) was used to estimate stream flow in the Upper Olifants catchment area.

AGWA was originally designed to obtain hydrologic parameters from the State Soil Geographic (STATSGO) and Soil Survey Geographic (SSURGO) databases, which are only available for the United States. The land type and land cover look-up tables were modified to represent South African conditions. Daily rainfall data from 15 rainfall stations within the Olifants catchment was compiled.

The model stream flow results were tested against the actual stream flow measurements at different points in the catchment. A good correlation between model stream flow and actual stream flow depends on the availability of the South African input and monitoring data. Further research priorities should focus on soil survey in the catchment, AGWA model inputs and actual stream flow data.

*Keywords:* Stream Flow, Olifants River Catchment, Modelling

## **22. A HOLISTIC APPROACH ON IRRIGATION FARMING MAKING USE OF TECHNOLOGY IN THE NORTHERN CAPE**

**Haarhoff, D and Bekker, A**

*P O Box 47, Douglas 8730, South Africa*

*E-mail: d.haarhoff@gwk.co.za*

Economical pressure on the irrigation farmers along the Orange-, Vaal- and Riet river systems in the Northern Cape was the big drive when this project was initiated by the Agri-service department of GWK. The primary goal was to evaluate the extent to which technology can be used by extension officers to help the farmers in managing their farms in the most scientific way. The emphasis was on practical manageable extension work which could be done in a sustainable way.

A High Technology service Packet was offered to the farmers and forty eight have participated during the 2006 winter planting season. This holistic project includes temperature monitoring, soil analysis, variable chemical application advice, chemical maps, water scheduling, penetrometer measurements, N-testing, yield maps, economical maps and NDVI maps. Four extension officers implemented the technology on a farm level and will continue to do so as long as they can add value to the farmers on the contracted 7881 hectares.

When the results were evaluated, chemical deviations between areas were significant. The behavior of chemical subsistence under different situations also led to variable recommendations which were not previously known on this scale. Most of the problems however were of a physical nature which were solved by making use of penetrometer interpretations and by correcting the water distribution from the centre pivots. With the use of yield and economical maps it was easy to quantify the problems and advise adjustments to farm practices.

*Keywords:* High technology farming, variable application, water scheduling, penetrometer measurements, yield maps, NDVI maps

## 22. HYDROLOGICAL GROUPING OF SOILS IN THE WEATHERLEY CATCHMENT OF SOUTH AFRICA

Van Huyssteen, CW<sup>1</sup> and Lin, H<sup>2</sup>

<sup>1</sup>Department of Soil, Crop and Climate Sciences, University of the Free State, PO Box 339, Bloemfontein 9300, South Africa; <sup>2</sup>Department of Crop and Soil Sciences, 116 ASI Building, Pennsylvania State University, University Park, PA 16802, USA  
E-mail: vhuystc.sci@mail.uovs.ac.za

Temporal stability of the volumetric soil water content was calculated for four measuring depths at 28 profiles in the Weatherley catchment of South Africa. Soil water contents were measured weekly with a neutron water meter for nine years from 1995 to 2005. Soil profiles were described and analysed using standard methodology. A marked variation in soil water content temporal stability was observed between the profiles, but soil water content was more stable with increased depth. Measuring layers and soil profiles were grouped in drier, average, and wetter based on the deviation of temporal stability ranking from the catchment mean. The ranking classification was related to soil chemical and morphological properties.

Silt and clay fractions increased with increasing wetness, and with increasing depth, but these differences were not always significantly different. Clay increased from 12.4 to 17.9 % in the drier and wetter classes at 150 mm to 23.4 to 29.1 % in the drier and wetter classes at 1 050 mm. Exchangeable Ca<sup>2+</sup>, Mg<sup>2+</sup>, sum of basic cations, and CEC of the soil also increased from the drier to the wetter wetness classes. Dry soil chroma generally decreased by two units with increasing wetness, from an average of 4 in the drier soil to 2 in the wetter soil. The difference was less for moist soil chroma, which decreased from 3 in the drier soils to 2 in the wetter soils.

At 150 mm, 750 mm and 1 050 mm mottle hue was almost one hue more yellow with increasing wetness (1.3, 2.2 and 3.3 hue units respectively). At 450 mm increasing wetness resulted in an almost half unit redder hue. Mottle value increased between 0.4 and 0.7 units, with increasing wetness, while mottle chroma increased between 1.1 and 2.6 units with increasing wetness. Differences in mottle colour between wetness classes generally decreased with increasing depth. This meant that mottles were less reliable to distinguish between wetness classes as depth increased.

It was concluded that it would be feasible to use volumetric soil water content temporal stability classification to differentiate between wetness classes. These classes can be used in deciding future soil monitoring layout and therefore limit instrumentation layout. Temporal stability classification can also be applied to group soils into hydrological response units, and to derive the soil's properties. This can be used in process-based hydrological modelling. These soil properties will, however, need to be verified for each new catchment, given the variation in geology and climate.

*Keywords:* colour, hydrology, mottles, temporal stability

## **23. WEED SUPPRESSION EFFECT ON YIELD OF COWPEA/MAIZE INTERCROPPING**

**Thobatsi, T<sup>1</sup>, Prinsloo, MA<sup>1</sup>, Reinhardt, CF<sup>2</sup> and Steyn, JM<sup>2</sup>**

<sup>1</sup>*ARC-Grain Crops Institute, P Bag X1251, Potchefstroom 2520, South Africa;*

<sup>2</sup>*Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002, South Africa*

*E-mail: thobatsit@arc.agric.za*

The objective of this field study was to evaluate possible weed suppression effects by different cowpea varieties of different growth duration when intercropped with maize. The experiment was conducted during the 2005/06 growing season at Potchefstroom and Bethlehem. Treatments were: maize sole, maize+Pan 311 (short duration cowpea cultivar), maize+Glenda (medium duration cowpea cultivar), maize+Agrinawa (long duration cowpea cultivar), and sole plots of all cowpea varieties. Each plot was divided into two weed levels where all the plots were kept weed free for one month after planting, after which one half was left weedy and the other half weed free. Weed sampling was done within each weed treatment during the late vegetative growth stage of the crops.

Cowpea cultivars yielded more in sole cropping compared to intercropping at both locations and the yield was also reduced by weed presence in both locations. At Bethlehem Glenda was more resistant to weed infestation in both sole and intercropping conditions while in Potchefstroom PAN 311 was more resistant. Maize grain yields were found to be significantly higher in sole maize cropping compared to intercropping for the drier western area with maize intercropped with Agrinawa and PAN 311 resisting weed infestation. Opposed to this, no differences were observed for maize grain yield between sole, intercropping and weed treatments in the wetter area. In general, weed biomass and density were found to be more articulated within sole plantings of both maize and cowpea compared to intercropping plots.

LER-values were highest with Agrinawa+maize at 1.67 and 1.19 followed by PAN 311+Maize at 1.40 and 1.08. Glenda+maize had the lowest LER at 1.03 and 1.04 for Potchefstroom and Bethlehem, respectively. Intercropping and weed presence reduced cowpea grain yield compared to sole cropping. Maize grain yield was not affected by different cowpea intercrops at Bethlehem while under drier conditions at Potchefstroom intercropping reduced maize yield. Intercropping compared to sole cropping significantly reduced weed biomass and density. At both locations, there was no need to intercrop for yield improvement but rather for weed control purposes.

*Keywords:* cowpea, intercropping, LER, maize, weed



## **24. GRAIN YIELD, YIELD COMPONENTS AND LAND USE EFFICIENCY OF DRYLAND MAIZE / COWPEA INTERCROP AS INFLUENCED BY PLANTING DENSITIES AND PLANTING PATTERNS**

**Moriri, SC<sup>1</sup>, Owoeye, LG<sup>2</sup> and Mariga, IK<sup>3</sup>**

<sup>1</sup>*ARC-Grain Crops Institute, P Bag X1251, Potchefstroom 2520, South Africa;*

<sup>2</sup>*ARC-Institute for Industrial Crops, P Bag X82075, Rustenburg 0300, South Africa;*

<sup>3</sup>*University of Limpopo, P Bag X1106, Sovenga 0727, South Africa*

*E-mail: moriris@arc.agric.za*

A rain fed experiment was conducted at three localities in South Africa. It was aimed at testing the effect of plant densities and planting patterns on intercropped cowpea and maize. The main plot treatments were the plant densities while subplot treatments were planting patterns. There were highly significant differences among planting patterns and plant densities across all locations. Maize yield increased almost linearly as the maize density increased up to 30 000 plants ha<sup>-1</sup> and decreased at higher density of 40 000 plants ha<sup>-1</sup> at all locations. The 1rowM:2rowsC had the highest maize grain yield compared to all other planting patterns. The average maize grain yield of the intercrops was higher by 37, 27 and 57% compared to sole cropping at Syferkuil, Potchefstroom and Taung. The highest cowpea grain yield was recorded in sole cropping and that was higher than the intercrops average by 57, 63 and 66% at Syferkuil, Potchefstroom and Taung. The 1rowM: 2rowsC arrangement had the highest cowpea grain yield and was higher by 30, 63 and 52% compared to all other planting patterns. A general trend of decreasing cowpea yield with increasing maize density was also observed. It appeared that 1rowM:2rowsC with maize density of 30 000 plants ha<sup>-1</sup> resulted in the highest maize grain yield. The highest cowpea grain yield was obtained in 1rowM:2rowsC planting pattern. Maize density of 10 000 plants ha<sup>-1</sup> had highest number of ear plant<sup>-1</sup>, kernel ear<sup>-1</sup>, rows ear<sup>-1</sup>, ear length and 100 grain weight compared to other maize densities and these were lower at 40 000 plants ha<sup>-1</sup>. Maize yield components increased with increased maize density and reduced at 40 000 plants ha<sup>-1</sup>. Sole cowpeas had the highest number of branches and pods plant<sup>-1</sup>. Seed pod<sup>-1</sup> and 100 cowpea grains weight were highest in 1rowM:1rowC at Syferkuil and Taung. Land equivalent ratio (LER) was also influenced by planting density and planting patterns compared to sole cropping. The highest LER values of 2.2, 1.5 and 4.4 at Syferkuil, Potchefstroom and Taung were obtained at 30 000 plants ha<sup>-1</sup> of maize density.

*Keywords:* intercrop, plant density, planting pattern, grain yield, land equivalent ratio

## **26. MAIZE YIELD COMPONENTS RESPONSE TO LABLAB PLANTING DATE AND DENSITY IN ROW MAIZE-LABLAB INTERCROPPING**

**Ngobeni, HM<sup>1</sup> and Ayisi, KK<sup>2</sup>**

<sup>1</sup>*ARC-Vegetable and Ornamental Plant Institute, P Bag X293, Pretoria 0001, South Africa;* <sup>2</sup>*University of Limpopo, P Bag X1106, Sovenga 0727, South Africa*  
*E-mail: ngobenim@arc.agric.za*

Maize is a crucial component of intercropping system on the farmer's field and therefore its yield has to be enhanced or maintained. Legume is important as a high protein crop, a source of forage for animals and sometimes a high cash crop, provided there is no significant sacrifice of cereal yield. Maize is the most important food crop in rural communities of many developing countries, and in the Limpopo Province of South Africa. Identifying lablab density that can maintain satisfactory growth and yield when simultaneously planted with maize will be important in sustaining the productivity of maize-lablab intercropping system where production resources is limiting. Field Experiments were planted on the 12<sup>th</sup> December at Dalmada and on the 13<sup>th</sup> December at Syferkuil during 2001/02 growing season, and in 2002/03 growing season, they were planted on the 6<sup>th</sup> and the 12<sup>th</sup> December 2002 at Dalmada and Syferkuil respectively. The treatments examined were five different density of lablab, namely: (0 (sole maize); 2; 4; 6; 8 plants per meter length) in the 2001/02 and an additional 10 plants per meter length in 2002/03. The objectives of the study were to determine the influence of lablab planting date and density on maize yield components and the relationship between maize yield components and grain yield. There was a general trend of decreasing maize yield components as lablab density increase under the simultaneous planting. When lablab was planted 28 days after maize, yield components of the associated maize crop were similar to or higher than the sole crop yield. Maize grain yield followed similar patterns as maize yield components.

*Keywords:* Maize, Lablab, Intercropping, Planting density, Planting date

## **27. INTERCROPPING MAIZE AND SWEET POTATO IN WESTERN KENYA: YIELD AND LAND USE EFFICIENCY**

**Webi, POW, Gohole, LS and Auma, EO**

*School of Agriculture & Biotechnology, Moi University, PO Box 1125-30100, Eldoret,  
Kenya*

*E-mail: pwebi@yahoo.com*

In the production of sweet potato most farmers in western Kenya practice relay cropping with maize where sweet potato is planted when maize is approaching physiological maturity. Rarely do they practice intercropping to maximize on time and space. The present study evaluated the land use efficiency of maize and sweet potato under different cropping patterns.

Three maize and three sweet potato cultivars with differing maturity periods (early, medium and late) were intercropped in two different cropping patterns in a 3 x 3 x 2 factorial combination treatment. The sole crops of maize and sweet potato served as the control plots. The trial was arranged in a Randomized Complete Block Design (RCBD) with 3 replicates for two consecutive cropping seasons. Data was collected on maize and sweet potato yield, grain weight per cob, mean tuber weight, number of tubers per plant and harvest index. Data was analyzed using ANOVA and treatment means separated using LSD. Land Equivalent Ratio (LER) was calculated to determine land use efficiency in the intercrop systems.

Maize grain yield in the intercrop treatments varied from 56 -150% more than the sole crop. The LER index identified 90% of the intercrop combinations as biologically more efficient varying from 1.10 to 1.76 meaning there was 10 - 76% higher land use efficiency due to intercropping. Sweet potato yield was 15 - 30% lower in the intercrops than the sole crop but overall in the year, the sweet potato yields were higher since harvests were from two cropping seasons instead of one. The results also suggest that the medium maturing maize and sweet potato cultivars are best suited for intercropping and also allow for successful growing of crops in two growing seasons in a year thus beneficial for the small holder farmers' need for food security and income.

*Keywords:* Intercropping, Maize, Sweet potato, Land equivalent ratio , Yield

## **28. A SIMPLE THREE-DIMENSIONAL SOLAR RADIATION INTERCEPTION MODEL FOR TREE CROPS**

**Abraha, M and Savage, M**

*Soil-Plant-Atmosphere Continuum Research Unit, School of Environmental Sciences,  
University of KwaZulu-Natal, P Bag X01, Scottsville, Pietermaritzburg 3209, South  
Africa*

*E-mail: 201504371@ukzn.ac.za*

Solar radiation is important in estimating dry matter production and evapotranspiration from agricultural fields. In this work, we simulate canopy radiation interception in sparsely vegetated tree crops. A three-dimensional, hourly time-step canopy radiation interception model is developed. The model assumes that trees are elliptical in shape with uniform leaf distribution, and that radiation attenuation within the canopy follows Beer's law. In order to determine the solar radiation at a point, the model calculates the path length of a radiation beam travelling through the canopy to reach the soil surface. Inputs of geographic location, altitude, row orientation, row and tree spacing, canopy size, extinction coefficient and incident solar radiation are required. Tube solarimeters are used to measure solar radiation below the canopy and compared with model estimates. The length of the tube solarimeters used was 0.25 m. Sensors were placed at 0.5 m distance from the base of a tree in four directions, along and perpendicular to the row up to mid-way between trees and rows. A datalogger was used to log 10-min solar irradiance and transmitted solar irradiance measurements for the winter to spring 2006 period. Model simulations are made to match the tube solarimeter positions. The simulations can be for either an isolated tree or for tree rows in which the effect of neighbouring trees is included. Preliminary simulations show that the model simulates solar radiation below the canopy reasonably well. At present improved simulations are at positions away from the tree than near to the tree, in northern than in the southern direction from the tree and for overcast rather than for clear sky conditions.

*Keywords:* Solar radiation interception, Modelling, Leaf area density, Canopy transmission

## 29. MONITORING TWO-DIMENSIONAL RADIATION INTERCEPTION AND DISTRIBUTION OF A YOUNG JATROPHA-KIKUYU ALLEY-CROPPING SYSTEM

Ghezehei, SB<sup>1</sup>, Everson, CS<sup>2</sup> and Annandale, JG<sup>1</sup>

<sup>1</sup>Dept. Plant Production and Soil Science, University of Pretoria; <sup>2</sup>CSIR, School of Environmental Sciences, Agrometeorology, University of KwaZulu-Natal, P Bag X01, Scottsville 3209, Pietermaritzburg, South Africa  
E-mail: sghezehei@csir.co.za

Solar radiation is a fundamental resource for plant growth. Its interception by component species and distribution in alley-cropping systems differs from that of monocropping systems, due to the interspecies interfaces in alley-cropping. The objectives of this study were to monitor solar radiation interception by trees and crops as well as radiation transmission to the soil surface at different distances across the tree-crop interface in order to develop a two-dimensional radiation interception model.

The experiments were carried out in a *Jatropha curcas* L. - *Pennisetum clandestinum* (kikuyu) sylvopastoral trial at the University of KwaZulu-Natal's Ukulinga Research Station, situated near Pietermaritzburg. The radiation measurements were made in four different treatments. These were: a treatment where kikuyu only was grown; a *Jatropha curcas* (*Jatropha*) only treatment (tree spacing 2.5 m X 2.5 m); a treatment where kikuyu was grown in the alleys between single *Jatropha* tree rows (alley width 5 m) and a plot where kikuyu was grown in the alleys between double rows (sets) of *Jatropha* trees (alley width 6 m and tree spacing 2.5 m breadth and 2 m length). Tree density was kept constant in all the plots at 1100 stems ha<sup>-1</sup>. Solarimeters, placed at a constant spacing of 0.5 m, were used to measure solar radiation. In the plots containing both *Jatropha* and kikuyu, solar radiation was also monitored beneath the tree and above the kikuyu, whereas in the plots containing one species only, radiation was measured using solarimeters placed at the soil surface. In all the plots containing *Jatropha* trees, the radiation measurements were made orthogonally to the mid point of the alleys, on both sides of the *Jatropha* rows. Solar radiation intercepted by *Jatropha* and kikuyu were determined from measurements of fractional interception made at the same locations as the solar radiation measurements.

Radiation measured at distances of 0.5 m to the left and 0.5 m to the right sides of the tree have shown differences, there were little or no differences between measurements at farther locations, at the same distances on both sides of the tree. As a conclusion, symmetricity in the amount and timing of radiation, at the same distance on both sides of the tree, reduced as one approaches the tree. It is to be expected that this reduction in symmetricity will stretch outwards the tree as the tree canopy dimensions increase.

**Keywords:** Solar radiation interception, Alley-cropping, Tree-crop interface, Fractional interception, *Jatropha curcas*, *Pennisetum clandestinum*

### **30. PREDICTION OF SOIL SURFACE EVAPORATION IN A SEMI-ARID AREA**

**Nhlabatsi, NN<sup>1</sup>, Van Rensburg, LD<sup>2</sup> and Walker, S<sup>2</sup>**

<sup>1</sup>*ARC-Institute for Soil, Climate and Water, P Bag X01, Glen 9360, South Africa;*

<sup>2</sup>*Department of Soil, Crop and Climate Sciences, University of the Free State, PO Box 339, Bloemfontein 9300, South Africa  
E-mail: nhlabatsin@arc.agric.za*

The CM-model modified from Choudhury and Monteith was used to predict soil surface evaporation (Es) under bare conditions. A previous study had concluded that the model could not predict Es well. The recommendation was that further investigations were necessary on both the CM-model and the way that the measured Es was estimated when using the soil water balance (SWB) method. Yet, a study by Kuschke had concluded that the CM-model simulated Es better than the model of Shuttleworth and Gurney. Based on this conclusion a different approach was used to quantify measured Es when using the SWB method, that is by separating the measured Es into cycles if it rained for more than or equal to 12 mm in any given time. There were seven Es cycles realized after the analysis of the water content data using the SWB method. The CM-model was calibrated, validated and evaluated with an independent dataset. The results of this study showed that the CM-model simulated Es well, based on Willmott inferential statistics. The CM-model performed well during the validation phase with a D-index of 0.89. The coefficient of determination ( $r^2$ ) was 0.76 which indicated a good performance overall by the CM-model. It can be concluded, therefore, that the CM-model can be used to simulate Es values in a semi-arid area.

*Keywords:* evaporation, clay soil

### **31. EVAPOTRANSPIRATION MEASUREMENT FOR A SILVOPASTORAL SYSTEM CONSISTING OF JATROPHA AND KIKUYU GRASS**

**Mengistu, MG and Savage, MJ**

*Soil-Plant-Atmosphere Continuum Research Unit, School of Environmental Sciences,  
University of KwaZulu-Natal, P Bag X01, Scottsville, Pietermaritzburg 3209, South  
Africa*

*E-mail: 201504370@ukzn.ac.za*

Understanding the water use of an agroforestry (silvopastoral) system is essential for evaluating tree-crop interaction when water is a limiting factor. Competition for resources, especially water is the major factor determining productivity in silvopastoral systems. The quantity of dry matter produced depends on the quantity of water transpired and the efficiency with which the transpired water is used in dry matter production. Evapotranspiration may be estimated using a variety of techniques, including soil water monitoring, lysimetry, and micrometeorological methods. Micrometeorological methods provide proper means of measuring water use in an agroforestry system, as they do not disturb the microenvironment and they minimize sampling problems by integrating fluxes over a substantial area. In this study, evapotranspiration was estimated using the surface renewal and eddy covariance methods. High frequency (10 Hz) air temperature data were collected at different heights above *Jatropha curcas* (Physic nut) and *Pennisetum clandestinum* (Kikuyu grass). Evapotranspiration was determined using sensible heat flux density, measured net irradiance, and soil heat flux density using the simplified energy balance equation for both surface renewal and eddy covariance methods. The half-hourly and daily evapotranspiration estimates from the surface renewal method showed very good agreement with the eddy covariance method. Evapotranspiration varied with time throughout the day and from day to day following the trend of fluctuations of the available energy. Evapotranspiration and the available energy were low in the early morning and late afternoon for most of the days and were at peak between 10 am and 2 pm.

**Keywords:** Evapotranspiration, Surface renewal, Eddy covariance, Silvopastoral system

## **32. EFFECT OF CERTAIN CLIMATIC CONDITIONS AND FERTILIZER PRACTICES ON THE INCIDENCE OF RIND PITTING IN 'BENNY VALENCIA' ORANGES**

**Magwaza, LS and Kruger, FJ**

*ARC-Institute for Tropical and Subtropical Crops, P Bag X11208, Nelspruit 1200, South Africa*

*E-mail: lembe@arc.agric.za*

Rind pitting is a physiological rind disorder of citrus that develops during storage. A study was conducted to investigate the relative effects that certain pre-harvest factors have on the post-harvest development of superficial rind pitting in 'Benny Valencia' oranges. Factors of particular interest were harvest maturity, climate and the mineral content of the fruit. One of the treatments involved the addition of two different formulations of nitrogen (LAN and slow release) during March 2006. The fruit were then sampled on a two weekly basis over a period of three months. On each sampling date, a set of quality related readings were taken, after which the mineral content of the exocarp and mesocarp was measured. The fruit were then stored under export simulation conditions.

The results indicated that fruit from trees that received additional N were more susceptible to rind pitting than control fruit. Of the two N applications, fruit from trees that received slow release N were more susceptible to rind pitting than fruit from trees that received the LAN treatment. Another important observation made was that the nitrogen content of oranges that received extra fertilizer was lower than that of the controls. In addition, the experimental fruit were smaller with thinner rinds than the control fruit. Again, fruit from trees that received the slow release treatment were smallest. Certain interesting trends were also made regarding the Ca, Mg, and titratable acid content of the oranges. Reductions in the Ca and Mg contents of the rind occurred concurrently with reductions in the pulp acid content of the fruit. The incidence of rind pitting significantly increased during the week following such an episode. A sink/source hypothesis aimed at explaining this phenomenon has been formulated and is currently being investigated. A number of control mechanisms are also to be explored.

*Keywords:* Rind pitting, Physiological rind disorder, Pre-harvest, Post-harvest, Fruit mineral content, Climatic conditions



### **33. EVIDENCE FOR A PHOTOPROTECTIVE FUNCTION OF ANTHOCYANINS IN PEARS**

**Roberts, SC<sup>1</sup>, Rosecrance, R<sup>2</sup> and Steyn, WJ<sup>1</sup>**

*<sup>1</sup>Department of Horticultural Science, Stellenbosch University, P Bag X1, Matieland 7602, South Africa; <sup>2</sup>Agricultural College, UCLA, USA  
E-mail: sroberts@sun.ac.za*

Anthocyanins, responsible for red peel colour in blushed 'Rosemarie' pears, reach a maximum in November, and then decline until harvest in January. Colour also improves transiently with the passing of cold fronts, but is lost again as temperatures rise afterwards. This loss of colour prior to harvest results in reduced returns for producers. The function of this pigmentation pattern is unknown, as it cannot be explained by dispersal theories. Knowing why anthocyanins accumulate and degrade in this pattern would aid future studies on red colour improvement. Our hypotheses are 1) reddest colour occurs mid-season because fruit are then horizontally orientated exposing previously shaded peel to full sunlight; and 2) that anthocyanins afford photoprotection to fruit peel chlorophyll in response to low temperature and high irradiance stress. Peel colour and photoinhibition were measured weekly, on the reddest and previously shaded positions, as immature fruit bent from vertical to horizontal during growth. Also, shaded fruit were exposed to sunlight; and peel colour and chlorophyll fluorescence quenching were measured over a number of days. The results from these trials show that previously shaded areas of fruit peel become redder and photoinhibition is reduced as fruit bend. However, the rapid recovery of photochemical quenching of shaded fruit after being subjected to full sunlight suggests that the mid-season peak in anthocyanins cannot be explained by the bending of the fruit to a horizontal position. Measurement of fruit colour 6-hourly during a cold front indicates that fruit become red quickly enough for the anthocyanins to provide photoprotection, when cool, sunny conditions occur once the cold front has passed.

*Keywords:* pear, fruit colour, anthocyanin, photoinhibition, chlorophyll fluorescence

### **34. AN INVESTIGATION OF THE FACTORS AFFECTING THE DEVELOPMENT OF MACADAMIA KERNEL DISCOLOURATION IN THE 'BEAUMONT' CULTIVAR**

**Masevhe, MR, Penter, MG and Kruger, FJ**

*ARC-Institute for Tropical and Subtropical Crops, P Bag X11208, Nelspruit 1200, South Africa*

*E-mail: mashudu@arc.agric.za*

Discolouration in macadamia ranges from a thin line around the equator of the nut to discolouration of the entire base of the kernel. Every year between 20 and 25% of all unsound kernel (USK) in South Africa is categorised as unsound due to discolouration. In the 2004 season this represented 117 tons of kernel with a potential value of R7 million if not discoloured. The aim of this trial was to evaluate the effect of various orchard factors on the development of discolouration. The work was conducted in the 2005 season at three orchards in the Hazyview area – two irrigated and one dryland. In 2006 it was expanded to an additional four farms in the Nelspruit, Barberton and White River areas. Initial findings show that discolouration is strongly affected by irrigation and rainfall, with dryland orchards showing the highest incidence of the disorder during dry spells. Rainfall brought about an immediate amelioration of the disorder in dry years, with dryland orchards showing the largest decline in the disorder. It was also seen that discolouration steadily declines in mature nuts left on tree. The distribution of certain elements showed strong correlations with the presence or absence of discolouration. This relationship between minerals and discolouration is currently under investigation.

*Keywords:* Macadamia discolouration, unsound kernel, dry land orchard, minerals, irrigation, rainfall

### **35. EFFECT OF ARBUSCULAR MYCORRHIZA (AM) FUNGI ON THE GROWTH RATE, BIOMASS ACCUMULATION AND NUTRIENT UPTAKE OF TROPICAL FRUIT SEEDLINGS**

**Chebet, DK, Rutto, LK, Wamocho, LS and Kariuki, W**

*JKUAT, PO Box 62000, Nairobi 00200, Kenya*  
*E-mail: chebetkd@yahoo.com*

The study was undertaken to determine the effect of AM fungi on the growth rate, biomass accumulation and nutrient uptake of passion fruit (*Passiflora edulis*), rough lemon (*Citrus limon*), mango (*Mangifera indica*) and papaya (*Carica papaya*) seedlings raised under four phosphorus regimes. Inoculation with AM fungi increased the plant height, leaf number and stem girth in relation to non-inoculated controls raised under equivalent P concentrations and an increase in vegetative growth parameters and in the uptake of phosphorus and potassium in the leaf tissues. Arbuscular mycorrhiza also favoured mycorrhizal infectivity of roots and increased the root absorptive surface area. This study indicates that AM fungi increase the capacity of tropical fruits to absorb and utilize phosphorus possibly by increasing the effective surface area from which available form of phosphorus is absorbed and also by increasing access of roots by bridging the depletion zones.

*Keywords:* Arbuscular mycorrhizae, phosphorus, fresh and dry weights, root infectivity

### **36. A COMPARATIVE STUDY ON THE GROWTH AND YIELD RESPONSE OF SOYBEAN TO TREATMENT WITH DIFFERENT BIO-PRODUCTS**

**Pretorius, JC<sup>1</sup>, Van der Watt, E<sup>1</sup>, Buitendag, RA<sup>1</sup> and Van Wyk, W<sup>2</sup>**

*<sup>1</sup>Department of Soil, Crop and Climate Sciences, University of the Free State, PO Box 339, Bloemfontein 9300, South Africa; <sup>2</sup>Zenzele Boerdery, PO Box 72178, Lynwood Ridge, Pretoria 0040, South Africa  
E-mail: pretorjc@mail.uovs.ac.za*

Treatment with six commercially available bio-products, Biozone 125, B-Rus and Leguspirflo (combined with Patostop), soil or foliar inoculants with micro-organisms as active substance, as well as ComCat™ and ComCat™ Super, natural extracts from wild plants, was compared in terms of their effect on growth, seed yield and quality. Although the mechanism of action of the inoculants differs from that of the natural plant extracts, claims made by the manufacturers are very similar. Neither of the products had a significant effect on top growth in terms of both plant height and the distance of the bottom pods from the soil. The most significant differences between treatments were observed at harvest where, compared to the untreated control, all test products had an increasing effect on the average number of pods per plant. However, this increase was only statistically significant where ComCat™ and ComCat™ Super were applied either as a seed treatment, a foliar spray or a combination of the two treatments. A single foliar treatment with ComCat™ at the 3-4 leaf stage as well as the seed-foliar spray combination treatment significantly outperformed both the Biozone 125 and Leguspirflo/Patostop treatments in this regard. The B-Rus treatment also showed a marked increasing effect in pod number. A similar tendency was observed in terms of final yield, calculated on a plant per hectare basis, where exactly the same pattern emerged. However, the marked increase in yield obtained with the B-Rus and ComCat™ treatments was the same although it did not differ significantly from the control and other treatments, probably due to large standard deviations between treatments. As no significant difference in 200 seed mass was measured between treatments, it is concluded that yield differences observed could be attributed to an increase in pod and seed number and not an increase in seed mass. Finally, the B-Rus treatment had an increasing effect on both crude oil and protein content in seed. Although the combined seed and foliar spray ComCat™ treatment decreased the crude oil content in seed, it increased the protein content by 1.63 percentage points.

*Keywords:* Soybean, Bio-products, Growth, Yield

### **37. THE INFLUENCE OF OMNIA'S K-HUMATE™ COATED FERTILIZER ON THE GROWTH OF DRY BEANS**

**Yeshitela, T, Mokoena, TCL and A'Bear, RM**

*Omnia Specialities (Pty) Limited, PO Box 69888, Bryanston 2021, South Africa  
E-mail: tyeshitela@omnia.co.za*

The effect of coating granular fertilizer with Omnia's liquid and powdered K-humate™ was investigated under greenhouse conditions at the Experimental Farm of the University of Pretoria. Dry beans were planted into pots fertilized with the equivalent of 350 kg/ha 6:3:4(32) fertilizer coated with either liquid or powdered K-humate™ and compared to controls that received uncoated 6:3:4(32) fertilizer. The fertilizer was coated at a rate of 3 litres of liquid K-humate™ tonne<sup>-1</sup> or the equivalent of the powder based on the humate concentration. Root and leaf mass were assessed every fortnight starting the 3<sup>rd</sup> week after planting up until the 9<sup>th</sup> week and again when harvested at 15 weeks. Treating the plants with K-humate™ coated fertilizer increased root and leaf mass ultimately resulting in a yield increase of 25%. Benefits were obtained with both the powdered and liquid formulations of K-humate™ and no statistical differences were detected between the two formulations. Initially only root mass responded to the K-humate™ application but in the 9<sup>th</sup> week after planting, increases were seen in fresh and dry root and leaf mass. Overall, less variation was seen in the K-humate™ treatments especially in the latter stages of the growth cycle. Omnia's K-humate™ was shown to have a positive effect on the development of dry beans resulting in a yield increase that would justify the cost of application.

*Keywords:* K-humate™, Coating, Yield

### **38. COMCAT®: A NEW PLANT STRENGTHENING AGENT NOW COMMERCIALY AVAILABLE**

**Van der Watt, E and Pretorius, JC**

*Department of Soil, Crop and Climate Sciences, University of the Free State, PO Box  
339, Bloemfontein 9300, South Africa  
E-mail: vdwatte.sci@mail.uovs.ac.za*

The recent interest in organic farming as well as the sharp increase in the application of natural products in the agricultural industry is probably due to consumer resistance towards the use of synthetic pesticides. These natural products can improve overall plant health by enhancing the natural resistance of crops towards abiotic and/or biotic stress factors. However, what is especially appealing is mounting evidence that even cultivars not known for their tolerance against stress conditions can be manipulated exogenously by triggering endogenous plant defence responses. *ComCat*<sup>®</sup>, a new natural plant strengthening agent, induces the resistance of crops against both abiotic and biotic stressors. Additionally, it improves root development, chlorophyll synthesis, plant vigour, flower bud formation and the translocation of photosynthate to harvestable parts. *ComCat*<sup>®</sup> was screened for its ability to induce the resistance of crops against abiotic and biotic stressors. Sunflower and soybean exposed to herbicide damage showed remarkable recovery after treatment with *ComCat*<sup>®</sup>. Further, carrots, cucumbers and tomatoes significantly resisted fungal infection under field conditions confirming an internal defence response after treatment with *ComCat*<sup>®</sup>. Similarly, turfgrass and garden plants treated with *ComCat*<sup>®</sup> showed an increase in ability to survive heat and drought conditions. As will be shown, *Comcat*<sup>®</sup> induces the expression of two specific genes in *Arabidopsis thaliana*, involved in natural defence mechanisms against abiotic and biotic stress factors respectively. Yields of most vegetable, fruit and row crops are significantly increased after one or more foliar applications of *ComCat*<sup>®</sup>.

*Keywords:* ComCat, plant protection, yield increase

### **39. THE EFFECT OF ORGANIC AMENDMENTS FOR NEMATODE CONTROL IN RURAL VEGETABLE GARDENS IN SOUTH AFRICA**

**Daneel, M, Tefu, G, Mdluli, D, Steyn, W and Poto, T**

*ARC-Institute for Tropical and Subtropical Crops, P Bag X11208, Nelspruit 1200, South Africa*

*E-mail: mieke@arc.agric.za*

A survey conducted in rural areas in the eastern and northern parts of South Africa revealed serious problems with nematodes, especially *Meloidogyne* spp. Due to the high nematode numbers, vegetable growing has become a problem and many gardens have been abandoned. Although these people have no funds available for nematicides, other practices could help reduce the problem and allow them to produce reasonable yields.

To determine the effect of organic amendments on yield and nematode numbers, two 2-year trials were done with vegetables at Nelspruit Experimental Farm. The treatments included cattle manure, chicken manure, compost, plastic filled with sterilized medium, permaculture, an untreated control, fenamiphos, oilcakes of soy and sorghum, sorghum, *Tagetes* and plastic cover (solarization).

After two years, results showed that permaculture delivered the best results for all the vegetables, even with very high nematode infestations in the tomatoes and spinach. Although nematodes are not affected directly, the effect on yield is huge. After two years and three crops, yield was enhanced by 60-80% compared to the control. Permaculture is a technique where a trench is dug and filled up with garden waste including green and brown material, old papers, rotten fruit and vegetables and then covered with soil. The second best treatment was chicken manure, followed by several other amendments. It is obvious that most of the amendments had a positive effect on the crops and although the direct effect on nematodes was insignificant, the benefit in terms of growth and yield were substantial.

**Keywords:** nematodes, control, organic amendments, permaculture, vegetables, rural farming

## **40. METEOROLOGICAL ASPECTS OF QUANTIFYING LAND PRODUCTIVITY POTENTIAL**

**Du Pisani, AL**

*ARC-Institute for Soil, Climate and Water, P Bag X79, Pretoria 0001, South Africa  
E-mail: dupisanil@arc.agric.za*

A pilot study was undertaken in Namibia to quantify land productivity potential for purposes of land tax and also in support of the resettlement programme. Climate, soil, and land-cover data were gathered so as to help quantify the productivity potential of the land in order to ultimately come up with an agricultural land value for further use. The author was charged with the task of gathering all available climate data for further use in modelling to determine the agricultural potential of the land. The pilot area chosen was between 22°S and 23°S and 17°E and 19°E. For purposes of interpolation, the grid was extended by  $\frac{1}{2}^\circ$  in all directions and the data for all 172 climate stations were used to come up with an interpolation for each  $\frac{1}{2}^\circ$  by  $\frac{1}{2}^\circ$  square. This paper gives the interpolated climate values and describes the general trend of rainfall throughout the pilot area. It also gives an indication of how to arrive at the production potential for the area.

*Keywords:* Land productivity



## **41. FINE RESOLUTION ATMOSPHERIC MODELLING OVER THE STELLENBOSCH WINE PRODUCING REGION**

**Roux, B**

*ARC-Institute for Soil, Climate and Water, P Bag X79, Pretoria 0001, South Africa  
E-mail: gerberb@arc.agric.za*

Certain climatic conditions are required for optimum physiological performance of vineyards. To identify areas for optimum vine growing, on-site climate information is required. As it is prohibitively costly to erect and maintain climate stations at all locations, climate models are considered worth investigating for obtaining simulated climate data at local scales. A fine resolution atmospheric model is used to simulate climate, where long observational records are absent, to identify the ideal locations for vineyards, and more particularly locations for vine cultivars, within the South African wine producing areas. Model simulations over the Stellenbosch region were performed using the Conformal-Cubic Atmospheric Model (C-CAM) which was developed by the CSIRO in Australia. C-CAM is regarded as a state-of-the-art model that makes use of some of the most advanced numerical techniques to solve the atmospheric equations. C-CAM simulations for February 2000-2005 over the Stellenbosch area were performed. The output is compared to station values in order to validate the model. Model output shows a good comparison to station values. It is expected that the results could serve as one of the bases for *terroir* selection and management in wine producing areas.

*Keywords:* Atmospheric modelling, C-CAM, Terroir

## **42. AGRICULTURAL CONTRIBUTION TO, AND MITIGATION OF, GREENHOUSE GAS EMISSIONS**

**Moeletsi, ME**

*ARC-Institute for Soil, Climate and Water, P Bag X79, Pretoria 0001, South Africa  
E-mail: moeletsie@arc.agric.za*

Agriculture plays an important role in the greenhouse gas balance sheet as there are different agricultural activities which contribute immensely to the emission and reduction of greenhouse gases. Agriculture's global share of anthropogenic emissions has been estimated to be about twenty percent of carbon dioxide, fifty percent of methane and seventy percent of nitrous oxide in the atmosphere. Four main greenhouse gas-emitting processes from agriculture are: 1) Methane and nitrous oxide emissions from domestic livestock; 2) Methane emissions from rice cultivation; 3) Methane, carbon monoxide, nitrous oxide, and oxides of nitrogen emissions from agricultural burning; and 4) Methane, carbon dioxide and nitrous oxide emissions from agricultural soils. Agriculture can also be fundamental in the mitigation of greenhouse gas emissions. Agricultural mitigation alternatives are recognized widely by many nations as the primary method of combating greenhouse gas emissions because they are more cost-effective than many options in other sectors. Three basic ways in which agricultural activities can reduce atmospheric build-up of the three most important greenhouse gases (carbon dioxide, methane and nitrous oxide) are: 1) Carbon sequestration, e.g. practising no-tillage cultivation; 2) Emissions reduction, e.g. use of more digestible animal feed like liquids to speed up the passage of food in the digestive system, thereby reducing production of methane; and 3) Fossil fuel substitution by usage of biofuels like bioethanol produced from maize or sugar cane as a replacement for petroleum.

*Keywords:* Greenhouse gases, Agriculture, Carbon dioxide, Methane, Nitrous Oxide

## **43. THE FUTURE OF MODELLING: MODELLING THE FUTURE**

**Van den Berg, M**

*South African Sugarcane Research Institute, P Bag X02, Mt Edgecombe 4300, South Africa*

*E-mail: maurits.vandenberg@sugar.org.za*

Over the past decades, computer based agronomic modelling research and development, at least in some fields, has shown an exponential increase. Modelling is believed to have contributed significantly to synthesise our understanding of crop-environment relations and to identify gaps in our knowledge, helping us to determine research priorities. Considerable efforts have also been devoted to develop model-based decision support systems, but with mixed results.

This discussion paper explores the future of agricultural modelling. The appropriateness of modelling to address specific issues is discussed against four criteria: (i) The threats or opportunities related to the issue; (ii) the (potential) contribution of modelling to resolve the issue; (iii) the efforts required to realise this potential; and (iv) the imminence of the issue. This reveals (obviously, in hindsight) that, rather than using computer models to assist decision processes that are reasonably well done without them (such as in most routine practices), models have the highest added value in areas where empirical knowledge is lacking and experimentation to generate such knowledge is very costly or impossible. These include, for example, assessment of favourable traits of cultivars that do not yet exist; supply chain optimisation, and impact of climate change. Complex combinations of models will increasingly be used to explore the future, helping strategic policy making by governments and major industries. For example, crop growth models can be combined with climate change models, demographic models, macro-economic models and land use change models to assess future demands and supplies of food, timber, bio-fuels and ecological services at spatially explicit levels. Such models will not be able to predict the future, but they will help to identify, for example, priority needs for technology development, and potential clashes between demands for food, (bio-)energy and nature. Such studies could be particularly valuable for South Africa, with its vast areas of highly valued but fragile ecosystems, large areas of marginal as well as highly productive agricultural lands, scarce water resources and accelerated socio-economic transformations.

Model-based tools to assist farmers in operational decision making will have their largest impact where growers must adapt to change, e.g. when facing restrictions regarding water use or burning (sugarcane). Close collaboration between researchers, modellers, farmers and advisers is needed to ensure practical utility of these tools, without compromising scientific rigour. Developments in strategic and operational decision support can be synergistic: strategic applications may attract considerable funds, but they need to derive credibility from the success of operational applications.

*Keywords:* modelling, decision support systems

#### **44. OPTIMIZATION OF FERTILIZATION (CHEMICAL AND ORGANIC) OF NEW SWEET POTATO CULTIVARS**

**Modisane, PC**

*ARC-Vegetable and Ornamental Plant Institute, P Bag X293, Pretoria 0001,  
South Africa*

*E-mail: pmodisane@arc.agric.za*

Sweet potato (*Ipomoea batatas*) roots are mainly used fresh for human consumption in South Africa. It is a good source of carbohydrates and contains substantial levels of several vitamins, minerals and protein. Dark orange-fleshed sweet potato cultivars are high in  $\beta$ -carotene, the precursor of vitamin A. The consumption of vitamin A rich sweet potato is addressing vitamin A deficiency in rural communities. The cultivation of sweet potato as a vitamin A rich source can thus be advantageous in rural communities where vitamin A deficiency is prevalent. 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. An initial trial was established in December 2004 in which two rates of organic and chemical fertilization (50% and 100%) were used based on soil analysis. A control treatment with no fertilization was also included in the trial. The impact of fertilization (organic and chemical fertilizer) on sweet potato storage root yield and quality was evaluated. Quality assessments included nutritional analysis of storage roots. A follow-up trial was conducted in December 2005 with six sweet potato cultivars, planted with two rates of organic and chemical fertilization (25% and 50%) based on soil analysis. The results of the follow-up trial indicated that increased fertilization did not lead to increased storage root yield, total soluble solids, carotene content, starch content or dry matter content. High storage root yield, total soluble solids, carotene content, starch content and dry matter content were produced with little or no fertilization. The outcome of the trials implied that sweet potato fertilizer recommendations were too high.

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

## **45. ASSESSMENT OF A FOOD-BASED PROJECT IMPLEMENTED IN LUSIKISIKI COMMUNITY TO ADDRESS VITAMIN A DEFICIENCY**

**Laurie, SM<sup>1</sup>, Faber, WM<sup>2</sup> and Mphaphuli, NS<sup>1</sup>**

<sup>1</sup>*ARC-Vegetable and Ornamental Plant Institute, P Bag X293, Pretoria 0001;* <sup>2</sup>*Nutritional Intervention Unit Medical Research Council (MRC), PO Box 1970, Tygerberg 7505, South Africa*  
*E-mail: slaurie@arc.agric.za*

One in three preschool children in South Africa suffers from vitamin A deficiency, and is therefore considered a public health problem. This is mostly due to staple-based diets with few vegetables and meats being consumed. A community-based model was developed by the MRC and ARC to address vitamin A deficiency through home gardens and nutrition education program. This model was implemented in Lusikisiki in the Eastern Cape in 2002 focusing on technology transfer and mobilization of local organizations. Training of agricultural extensioners and lead farmers, establishment of demonstration gardens with butternut, carrot, orange-flesh sweet potato and spinach (swiss chard) and nutrition education and growth monitoring of preschool children by project health volunteers formed the basis of the project. A survey was done four years after implementation to assess the impact of the project. Data was collected by questionnaire. The major finding of the impact assessment will be discussed, showing a positive affect on the awareness of nutrition aspects, and on the intake of pro-vitamin A-rich vegetables. Group discussions with project volunteers indicated that the training capacitated those involved in the project since previously they only planted maize and beans and had to buy pro-vitamin A-rich vegetables. Because of their participation in the project they are now knowledgeable as how to cultivate pro-vitamin A-rich vegetables, they provide for the nutritional needs of their children and have additional income to buy other commodities. In some areas up to 1 hectare of orange-fleshed sweet potato are cultivated and though it is a new crop in the area, people find it delicious. The success of the project at Lusikisiki showed that the approach can be implemented on wider scale through technology transfer to local organizations and communities.

*Keywords:* food diversification, food gardens, orange-fleshed sweet potato, pro-vitamin A-rich vegetables

## **46. EFFECT OF FOLIAR FERTILIZATION ON COFFEE (*COFFEA ARABICA* L.) SEEDLINGS**

**Gonzo, Z<sup>1</sup> and Madakadze, IC<sup>2</sup>**

*<sup>1</sup>FSI Seeds, Box WGT 989, Westgate, Harare, Zimbabwe; <sup>2</sup>Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002, South Africa  
E-mail: gonzoz@fsiagricom.co.zw*

There is evidence that foliar fertilizers improve plant growth, quality and yield of many plant species. An experiment was carried out to evaluate the effects of Kelp-P-Max, a foliar fertilizer, on coffee seedlings in a nursery. The effects of two application intervals (2 weeks or 4 weeks) and four doses (0%, 0.2%, 0.4% and 0.6%) were tested in a 2 by 4 factorial experiment laid out in a three block RCBD. Destructive sampling was done for dry matter determination, after taking height, girth and leaf area measurements. Harvests were done every four weeks for six months and the experimental unit was 5 plants. There were no consistent trends on application intervals. On the other hand, there was no effect ( $p < 0.05$ ) of foliar fertilization before the third harvest. On the third harvest there were differences ( $p < 0.05$ ) between the means of all measured parameters and 0.2% was the optimum dose. Later harvests showed diminished effects of Kelp-P-Max application at all doses. It was concluded that foliar fertilization is beneficial to coffee seedlings at earlier stages of growth. Further studies are suggested, particularly on the stage at which to begin applying coffee seedlings with foliar fertilizers as well as on different doses for the different stages during the phenological development of the seedling.

*Keywords:* foliar fertilizer, coffee seedling, Kelp-P-Max

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

**Mupondi, LT, Mnkeni, PNS and Muchaonyerwa, P**

*Department of Agronomy, Faculty of Science and Agriculture, University of Fort Hare, P  
Bag X1314, Alice 5700, South Africa  
E-mail: s200303473@ufh.ac.za*

The potential of composts made from pine bark co-composted with goat manure (PBGM), when compared with pine bark (PB) compost, was evaluated as growing media for transplant seedlings. Composts were analysed for chemical and physical parameters 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 the slow release Horticorte 7:1:2 (22) fertilizer. Germination was determined two weeks after sowing and crops were allowed to grow for 4 weeks after which both the shoot and root biomass were harvested and fresh and dry weights determined. Shoots were analysed for N, P and K contents. Results showed that 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 be 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, PBGM reduced germination by up to 15% relative to PB. Growth of the crop transplants was better in the PBGM compost. In both substrates increasing nutrient availability by adding slow-release fertilizer had similar positive effects on growth of transplants. Significant fertilizer-growing medium interactions were observed in both fresh and dry matter yields of shoots for all the crops. Results revealed that PBGM supported good seedling growth and could thus be a good substitute for PB as a growing medium. Despite the superior nutritional value of this potential alternative growing medium, nutrient supplementation may still be necessary where seedlings are kept in the nursery for extended periods due to nutrient exhaustion. 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, growing medium, slow release fertilizer

## **48. VEGETABLE PRODUCTION IN FLORIDA**

**Cantliffe, DJ**

*University of Florida/Institute of Food and Agricultural Sciences, Horticultural Sciences  
Dept, PO Box 110690, Gainesville FL 32611-0690 USA*

*E-mail: djc@ifas.ufl.ed*

Florida's vegetable production is extremely unique in that crops are produced primarily out of season in the fall, winter and spring months of the year. Florida's major soil type is a sandy soil with almost no organic matter and small amounts of clay and silt. The majority of Florida's vegetables are produced below the Interstate 4 corridor, which is an Interstate Highway running from Daytona Beach to Tampa, Florida. Approximately 80% of the value of our crops are produced as winter vegetables below this line. The major vegetable crops are all produced for fresh market and include snap beans, broccoli, cabbage, carrots, cauliflower, celery, chinese cabbage, collard greens, cucumbers, eggplant, endive, escarole, lettuce, mushrooms, okra, onions, parsley, peas, peppers, potatoes, radishes, romaine lettuce, spinach, squash, sweet corn, sweet potatoes, tomatoes, turnips, turnip greens, watercress and yucca.

In Florida, strawberries are also considered a vegetable crop because it is produced on an annual basis. In the most recent statistics from the season 2004-2005, Florida's value was \$1.9 billion for vegetables, second only to that of California. Florida produced 49% of the fresh market value of tomatoes in the U.S., 44% of bell pepper value, 31% of cucumbers and 31% of watermelon. Florida ranks first in sales of snap beans, tomatoes, cucumbers, squash and peppers, and second in sales of sweet corn and strawberry. Florida's agriculture has long been established for delivering fresh vegetables to the Eastern United States during the winter months. Presently, there are many demands on Florida agriculture that has threatened its future, including urbanization, transportation, labor and the loss of methyl bromide. It is thought, however, that Florida agriculture will remain viable for many decades into the future.

*Keywords: vegetables, Florida*



## **49. USING SPECIFIC WAVELENGTHS OF LIGHT – A NEW MEANS TO ENHANCE COLOURATION OF STRAWBERRY FRUIT?**

**Bertling, I and Flanagan, MD**

*Horticultural Science, University of KwaZulu-Natal, P Bag X01, Scottsville,  
Pietermaritzburg 3209, South Africa  
E-mail: bertlingi@ukzn.ac.za*

Strawberry fruit enjoy worldwide popularity due to their colour, aroma and intense, sweet taste. As consumers mainly buy a commodity due to its appearance, the intensely red colour of strawberries is of utmost importance once they reach the market place. In an attempt to enhance the colour of developing strawberry fruit via the induction of anthocyanin synthesis, plants were cultivated in a controlled environment and treated with specific wavelengths and periods of light. The treatments involved the use of specific wavelengths to flowering plants for ten minutes and a daylength extension for 4 hours. Treatments were applied for a period of ten days. It was found that the greater the level of plant stress induced by the light, the greater the anthocyanin accumulation in the fruit. Fruit treated with low intensity 'black' light (345-360nm) synthesized the highest concentration of anthocyanins and had the best overall colouration. Fruit treated with low intensity mercury vapour light (360-400nm) were poorly coloured as a result of poor anthocyanin accumulation, and those exposed to daylength extension had a significantly lower accumulation of anthocyanins than the other treatments. Therefore, the use of specific lights could result in fruit achieving higher economic returns.

*Keywords:* strawberry, light

## **50. PRUNING AND TRELLISING OF HYDROPONICALLY GROWN CHERRY TOMATO CULTIVARS**

**Maboko, MM and Du Plooy, CP**

*ARC-Vegetable and Ornamental Plant Institute, P Bag X293, Pretoria 0001,  
South Africa*

*E-mail: mmaboko@arc.agric.za*

The effect of pruning and trellising on yield and quality of hydroponically grown cherry tomato cultivars (Naomi and Josefina) were investigated. The three stem trellising treatments applied were plants pruned to 1, 2 or 3 stems. The experiment was designed as a randomised block design with three replicates. Measurements were taken of fruit number and fruit mass according to fruit size, i.e. extra large (>35 mm), large (30 – 35 mm), medium (25 – 30 mm), small (20 – 25 mm) and extra-small (<20 mm). The number of fruit exhibiting cracks and their mass, green fruit number and their mass, and %Brix (total soluble solids) were determined. In general, a higher number of extra large fruit, and, thus fruit mass, were obtained from plants pruned to a single stem compared to plants pruned to two or three stems in both cultivars. Cultivar Josefina had a significantly higher number of medium and small sized fruit and fruit mass, with fewer extra-large fruit and fruit mass than that observed for cultivar Naomi. Cultivar Naomi had a low %Brix and a higher susceptibility to fruit cracking than cultivar Josefina. Regardless of cultivar, both two and three stem treatments were effective in reducing fruit size as required by the market. The study demonstrated that fruit size can be effectively manipulated by cultivar selection, stem trellising and pruning.

*Keywords:* cultivar, fruit size, pruning, stems, yield

## **51. GROWTH AND YIELD OF *CAPSICUM BACCATUM* AS INFLUENCED BY TEMPERATURE AND PHOTOPERIOD**

**Soundy, P, Eiasu, BK, Du Toit, ES and Van Vuuren, A**

*Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002, South Africa*

*E-mail: puffy.soundy@up.ac.za*

*Capsicum baccutum* (pepper) was grown in Pretoria at selected temperatures in either growth chambers with controlled photoperiod or glasshouses with natural light duration. The treatments included 25/15°C day/night, 30/20°C day/night and variable temperatures that were adjusted every month. The higher temperature treatment (30/20°C day/night) resulted in faster vegetative growth inside the growth chambers with stems that were weak and had long internodes. More and larger leaves were also produced, but they were lighter in color. At the lower temperature treatment (25/15°C day/night), leaves were fewer but darker in color. Greater fresh root mass was obtained in plants that were grown at 30/20°C day/night temperature. The duration between flowering and fruit maturity was not affected by temperature.

However, in the 30/20°C day/night treatment, flower abortion occurred, and irregularly shaped fruit, light colored fruit and fruit with soft pericarps developed. There was also a high incidence of black spots on the fruit from the higher temperature treatment. Fruit yield was significantly higher in the lower temperature treatment probably because of many fruit initials, regularly shaped fruit with no black spots coupled with a longer harvesting duration. The harvesting duration was limited to about three months in the higher and variable temperature treatments.

This particular variety of pepper appears to be day length sensitive. Plants failed to flower in the glasshouse even at favorable temperatures between April and mid August. Flowering stopped when day length dropped to 11 hours. When plants were moved to the growth chamber from the glasshouse and subjected to 12 hours of light, they started to flower. This study demonstrated that high yields of quality *Capsicum baccutum* can be obtained at 25/15°C day/night temperature with at least a 12 hour photoperiod.

*Keywords:* pepper, fruit yield, fruit quality, temperature, day length

## **52. RESPONSE OF HERBAGE YIELD, ESSENTIAL OIL YIELD AND COMPOSITION OF ROSE-SCENTED GERANIUM (*PELARGONIUM* SP.) TO CONVENTIONAL AND ORGANIC NITROGEN**

**Araya, HT, Soundy, P and Steyn, JM**

*Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002, South Africa*  
*E-mail: thintsa@yahoo.com*

A field experiment was conducted on rose-scented geranium in Pretoria to evaluate the response of plants to amount and source of N. Treatments consisted of two sources of N, comprising conventional or organic fertiliser sources at 100, 200 and 300 kg ha<sup>-1</sup> N year<sup>-1</sup> and a control (zero kg ha<sup>-1</sup> N year<sup>-1</sup>). The experiment was laid out in a randomised complete block design. The oil content of the plants (sub sample of 10 kg from each treatment) was determined by steam distillation and oil samples were analysed by gas chromatography (GC). At the first harvest (summer/autumn), there was no significant effect of conventional N on fresh herbage and essential oil yield, probably due to leaching of N by rainfall. However, organic N at 100 kg ha<sup>-1</sup> increased fresh herbage and essential oil yields by 57.5% and 47.9% over the control, respectively. In the second harvest (spring/summer), fresh herbage yield increased by 46.3% (conventional N) and 60.3% (organic N) at 100 kg ha<sup>-1</sup> compared to the control. Compared to the control, 100 kg ha<sup>-1</sup> conventional and organic N also increased essential oil yields by 93.6% and 129.4%, respectively. Leaf area, plant height and dry mass increased with increase in N levels of both sources, in both harvests. Increasing N levels of both sources increased citronellol percentage, in the first harvest. In the second harvest, organic N increased citronellol percentage, whereas conventional N had no effect. In both harvests, no effect of conventional N was observed on geraniol percentage compared to the control. Except for the 100 kg ha<sup>-1</sup> level, the same was true for organic N. In the first harvest, application of conventional N beyond 200 kg ha<sup>-1</sup> and all levels of organic N reduced guaia-6,9-diene percentage, while in the second harvest, it was not significantly influenced by either source or level of N. This study revealed that rose-scented geranium produced higher fresh herbage and essential oil yield when organic fertilizer was used as a source of N. Furthermore, N application influenced oil composition.

*Keywords:* Essential oil yield, essential oil composition, rose-scented geranium

### **53. DEVELOPING ESSENTIAL OILS AS COMMERCIAL CROPS IN RURAL AREAS OF THE EASTERN CAPE**

**Du Preez, RJ<sup>1</sup>, De Jager, K<sup>1</sup>, Jones, PC<sup>2</sup>, Bongo, MG<sup>2</sup>, Ngoko, G<sup>3</sup>, Sikosana, DN<sup>1</sup> and Roets, N<sup>1</sup>**

<sup>1</sup>ARC-Institute for Tropical and Subtropical Crops, P Bag X11208, Nelspruit 1200, South Africa; <sup>2</sup>Is'Baya Development Trust, 39 Drama Street, Somerset West, South Africa;

<sup>3</sup>Is'Baya Development Trust, Mthatha, South Africa

E-mail: rosedup@arc.agric.za

Essential oil crops have not traditionally been produced in South Africa and offer numerous opportunities for diversification and value adding. A number of these essential oil crops can be grown by emerging farmers in rural areas and offer additional economic opportunities as processing and value adding would be carried out on-farm. The aim of this initiative is to develop successful commercial growers of herbs in rural areas of the Eastern Cape, South Africa. This was initiated by planting of on-farm trials in participating villages in the former Transkei. The initial trial plantings will be expanded after completion of the trial phase to ensure sustainable, commercial plantings of herbs.

The introduction of herbs to the Eastern Cape was initiated during 2002. Initial activities focused on creating awareness of the potential of essential oils as a commercial crop. Trials were established in the Chris Hani district at 4 localities and in the O R Tambo district at 11 villages. The specific herbs planted at each trial site (village) were selected according to local climate, soil and market demand, with a minimum of 4 herb types being planted. The herbs from each site were harvested and oil extracted. Yield and composition of the oils were determined. Rosemary yielded between 0.5 and 1.44% oil, rose geranium between 0.13 and 0.48%, lemon grass between 0.4 and 0.6% oil, thyme yielded between 0.5 and 0.67% oil and oreganum between 0.5 and 1.29% oil. Initial results have clearly shown the suitability of the areas for planting herbs and the introduction of herbs as a potential commercial crop has been extremely successful. From these trial plantings the effect of the local climate and soil conditions on the yield and quality of the oils can be determined and from this pilot phase the plantings can be expanded to produce marketable volumes of quality oils.

Many lessons have been learnt to date and a methodology for the successful introduction of a new crop into an area has been developed and will be discussed.

*Keywords:* Essential oils, Rural development, Eastern Cape, Oil yields, Oil composition

## **54. RESPONSE OF ROSE-SCENTED GERANIUM (*PELARGONIUM SP.*) ESSENTIAL OIL TO LONG-TERM AND BRIEF MOISTURE STRESS**

**Eiasu, BK, Soundy, P and Steyn, JM**

*Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002,  
South Africa*

*E-mail: bkef68@yahoo.com*

Moisture, directly or indirectly, plays a major role in the biosynthesis of plant secondary metabolites such as essential oils in various plant species. Pot experiments were conducted to investigate the impact of irrigation frequency and a one-week irrigation withholding period on rose-scented geranium herbage yield and essential oil yield and composition. In a tunnel, treatments consisted of a combination of three irrigation frequencies (twice a day, once day and every second day) and two growth media (silica sand and sandy clay loam) allocated to the main plots, with one-week irrigation withholding treatments as sub plots. In a glasshouse, sandy clay loam soil was used as growing medium, and five irrigation frequencies (irrigated to pot capacity every day, every 2<sup>nd</sup>, every 3<sup>rd</sup>, every 4<sup>th</sup> and every 5<sup>th</sup> day) were applied as treatments. Both herbage and essential oil yield responded positively to irrigation frequency. Thus, the higher the total water received by the plants, the higher was the herbage and essential oil produced. One-week stress period enhanced essential oil yield and influenced oil composition. The results highlighted that sufficient moisture during growth, followed by a brief stress before harvesting, maximizes rose-scented geranium essential oil yield.

*Keywords: Pelargonium sp., rose-scented geranium, essential oil, irrigation*

**55. PLANT SHOOT AGE AND TEMPERATURE EFFECTS ON ESSENTIAL OIL YIELD AND OIL COMPOSITION OF ROSE-SCENTED GERANIUM (*PELARGONIUM SP.*) GROWN IN SOUTH AFRICA**

**Motsa, NM, Soundy, P and Steyn, JM**

*Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002, South Africa*

*E-mail: s25085850@tuks.co.za*

A field experiment was conducted during 2005/2006 at the Experimental Farm of the University of Pretoria, South Africa, to investigate the changes in herbage yield, oil yield and the variation in the concentration of the major components of rose-scented geranium with plant shoot age. Essential oil was extracted by steam-distillation and the composition was determined by gas chromatography (GC). The results revealed that herbage yield increased over time in the first four (autumn/winter) and five (spring/summer) months of the respective harvesting cycles. The plants harvested in the spring/summer cycle had higher herbage yield and oil percentage than plants harvested in the autumn/winter cycle. The decrease in oil percentage was associated with low night temperatures in the autumn/winter cycle. To verify whether oil percentage was also affected by plant shoot age, microscopic analysis of rose-scented geranium leaves were studied. Leaf samples from different positions on the plant and differing in age were used. It was found that the oil gland density decreased with leaf age on the same plant. This result, however, did not overrule the fact that higher herbage yield increases oil yield. Geraniol content decreased with decreasing night temperatures in autumn/winter while citronellol content showed a tendency to increase. Geraniol followed a similar trend when regressed against plant shoot age in both experimental cycles. The decrease in geraniol content with respect to plant shoot age, therefore, increased the citronellol: geraniol ratio in both experimental cycles. The spring/summer harvesting season was superior to the autumn/winter season in all commercial aspects of rose-scented geranium essential oil production.

*Keywords:* Rose-scented geranium, essential oils, citronellol, guaia-6,9-diene, citronellyl formate , geraniol, geranyl formate

## **56. THE EFFECTS OF CULTURAL PRACTICES ON THE BIOMASS AND YIELD OF ROSEMARY (*ROSMARINUS OFFICENALIS*)**

**Sikosana, DN<sup>1</sup>, Du Preez, RJ<sup>1</sup>, Soundy, P<sup>2</sup> and Du Toit, ES<sup>2</sup>**

<sup>1</sup>*ARC-Institute for Tropical and Subtropical Crops, P Bag X11208, Nelspruit 1200;*

<sup>2</sup>*Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002, South Africa*

*E-mail: daphney@arc.agric.za*

Rosemary is not a traditional crop in South Africa. Currently there has been an interest in growing the crop communally; however, there is very little information available on cultural practices under conditions. The aim of the trial was to investigate the effect of plant population density, mulching, fertilizers, harvesting and the effect of storage sequence on biomass and quality of rosemary oil. The preliminary results of the effect of spacing, mulching, and fertilizers on the biomass and oil yield will be discussed. The trial was conducted at the ARC-ITSC farm, Nelspruit. The treatments used for this experiment were mulching or non-mulching in combination with three plant spacing and two of fertilizer treatments. The grass straw mulch was applied at a thickness of +/- 3cm and the rosemary was spaced at 0.3m, 0.5m and 0.7m respectively. Organic fertilizer with varied levels of nitrogen was applied at 5kg and 8kg per plot.

Mulching significantly suppressed the germination of weeds. The results for spacing and fertilizers will be analysed and discussed. The oil yield was analyzed immediately after harvest and the other materials stored for three weeks. The oil yield was significantly higher in stored materials when compared to material distilled immediately after harvest. The effect of harvesting method on quality of the oil compound will be discussed.

*Keywords:* Biomass, Oil quality, fertilizers, quality, rosemary, harvesting, mulching, spacing



## **57. CELL WALL COMPOSITIONAL DIFFERENCES BETWEEN MEALY AND NON-MEALY 'FORELLE' PEAR**

**Crouch, EM and Huysamer, M**

*Department of Horticultural Science, Stellenbosch University, P Bag X1, Matieland  
7602, South Africa  
E-mail: elke@sun.ac.za*

Mealiness of 'Forelle' pear during ripening is a problem for the South African export market. The aim of this work was to investigate the occurrence of mealiness-induced differences in cell wall polysaccharides of 'Forelle' pear within the same harvesting date, cold storage and ripening duration, to be able to understand why mealiness occurs. Cell walls were extracted and de-starched with 90% DMSO and total neutral sugar (NS), and uronic acid (UA) content measured. Samples were sequentially extracted with H<sub>2</sub>O, CDTA, NaCO<sub>3</sub>, 4% KOH and 24% KOH to determine differences in binding strength of the cell wall constituents between mealy and non-mealy tissues. Total NS and UA were measured for each of these extractions after dialysis, and specific NS identification was done by gas chromatography. The UA content of ionically bound pectin (CDTA fraction) and the NS content of covalently bound pectin (NaCO<sub>3</sub> fraction) were lower in mealy tissues. There was a loss of Galactose in all extracts except for the H<sub>2</sub>O fraction for mealy fruit. Arabinose content in the CDTA fraction was less in mealy tissues compared to non-mealy tissues, but was extracted from the very tightly bound hemicellulose fraction (24% KOH). It appears that loosely bound pectin of mealy tissues is more broken down than in non-mealy tissues. The high amounts of Arabinose in the 24% KOH fraction might indicate that some of the rhamnogalacturonan-I side chains are bound very tightly into the hemicellulose fraction. This could give it the potential to bind free juice even though the middle lamella is more broken down. The significance of these results will be further discussed.

*Keywords:* Pear, Cell wall, Mealiness

## **58. DETECTION OF GRAFT INCOMPATIBILITY IN *UAPACA KIRKIANA* FRUIT TREES USING PHENOL ANALYSES**

**Mng'omba, SA<sup>1</sup>, Du Toit, ES<sup>1</sup>, Regnier, T<sup>2</sup>, Akinnifesi, FK<sup>3</sup> and Venter, HM<sup>4</sup>**

<sup>1</sup>*Department of Plant Production and Soil Science, Faculty of Natural and Agricultural Sciences, University of Pretoria, Pretoria 0002, South Africa;* <sup>2</sup>*Department of Microbiology and Plant Protection, Faculty of Natural and Agricultural Sciences, University of Pretoria, Pretoria 0002, South Africa;* <sup>3</sup>*SADC-ICRAF, Agroforestry Programme, PO Box 30798, Lilongwe 3, Malawi;* <sup>4</sup>*Tree Improvement, Natural Resources and Environment, PO Box 395, Pretoria 0001, South Africa*  
E-mail: s23368854@tuks.co.za

The objective was to determine the effect of phenols accumulating at the graft union interfaces on graft compatibility in *U. kirkiana* fruit trees. Total soluble phenols were extracted with methanol-acetone-water and then application of Folin-Ciocalteu reagent. Cell wall bound phenols were extracted and precipitate suspended in 80% methanol before high performance liquid chromatograph (HPLC) analysis. Thin layer sections (10 µm) were viewed under UV, blue and white light with or without Vanillin-HCL staining using a fluorescence microscopy. Results showed significant differences in both soluble and insoluble phenols at the unions. Heterospecific combinations showed high amount of soluble phenol above the union. Fluorescence microscopy indicated presence of flavonoids, anthocyanins or their derivatives above the union of the graft *Uapaca kirkiana* fruit trees. HPLC analysis showed ferulic acid as a major component responsible for wood discolouration. MW12/12 graft combination was less compatible and p-coumaric acids was identified with high peak above the union. Therefore, p-coumaric acids was implicated in graft incompatibility of *U. kirkiana* fruit trees.

*Keywords:* Euphorbiaceae, p-coumaric acids, wood discolouration, homograft

## **59. ETHEPHON EFFICACY AND REGISTRATION TRIALS FOR SOUTH AFRICAN MACADAMIAS**

**Penter, MG**

*ARC-Institute for Tropical and Subtropical Crops, P Bag X11208, Nelspruit 1200, South Africa*

*E-mail: mark@arc.agric.za*

The South African macadamia industry is based mainly on imported cultivars, with 'Beaumont' being the most widely planted. At present 'Beaumont' represents about 60% of the trees in the industry. The major drawback to this cultivar is that more than 80% of mature nuts fail to abscise in the harvest season.

Preliminary trials in 2000 indicated that ethephon had the potential to abscise most of the nuts on 'Beaumont' trees. Work carried out since then has examined factors such as application rate, timing and method of application. Also investigated were the effects of adjuvants such as urea, phosphates and various wetting agents on the efficacy of the product. In 2005 the trials were extended to include the four cultivars most widely grown after 'Beaumont'. At the same time a number of closely monitored semi-commercial trials were conducted on various farms.

In the 2004-2005 and 2005-2006 seasons, the focus of the work moved to registration trials and included extensive residue testing. This work has been conducted in conjunction with the South African Bureau of Standards (SABS) under the auspices of the EU co-funded South African Pesticide Initiative Program (SA-PIP). To date no residues have been detected for application rates of up to 2000ppm. This paper will cover the highlights of the trials to date.

*Keywords:* Macadamia, ethephon, registration

## **60. IMPROVING THE QUALITY OF TABLE GRAPES WITH OPTI-K™**

**Kellerman, MCE<sup>1</sup>, A'Bear, RM<sup>2</sup> and Steenkamp, J<sup>1</sup>**

<sup>1</sup>*Omnia Specialities, PO Box 1034, Durbanville 7551, South Africa;* <sup>2</sup>*Omnia Specialities, PO Box 69888, Bryanston 2021, South Africa*  
*E-mail: mkellerman@omnia.co.za*

Size counts in the table grape market – the bigger the berries, the better the quality and the higher the income that is generated. With this in mind, trials were conducted during the 2004 and 2005 seasons in the Hexriver Valley of the Western Cape to evaluate the influence of OPTI-K™ on berry size and berry quality. An increase in yield and berry size was seen during the 2004 season.

In 2005, the OPTI-K™ foliar was applied to a wide range of cultivars on acidic, sandy soils, high in phosphorus and calcium, low in potassium, with variable levels of magnesium and in general, acceptable levels of sodium.

OPTI-K™ was applied at a rate of 8 l/ha as a foliar spray with two applications made during the season. The first was at the start of veraison (when 5% of the berries had colored) and again 7 days later, when the majority of the berries had colored.

The treatment resulted in fewer fruit being rejected at the pack shed and for every tonne of fruit harvested the amount of poor quality fruit was reduced by 35kg. This was equivalent to an additional 8 boxes of fruit per tonne of fruit harvested. Applying OPTI-K™ at this stage of development did not affect the yield but had an important impact on fruit quality and the increased profitability of the orchard.

*Keywords:* quality, berry size, table grapes, OPTI-K™

## **61. THE EFFECT OF FIRST RATOON SUCKER SELECTION ON PLANT GROWTH AND YIELD POTENTIAL OF TISSUE CULTURED CAVENDISH BANANAS**

**Fraser, C<sup>1</sup>, Robinson, JC<sup>2</sup> and Bower, JP<sup>3</sup>**

<sup>1</sup>*Burgershall Research Station, P Bag X501, Kiepersol 1241;* <sup>2</sup>*Du Roi Laboratory PO Box 1147, Letsitele 0885;* <sup>3</sup>*Horticultural Science, University of KwaZulu-Natal, P Bag X01, Scottsville, Pietermaritzburg 3209, South Africa*  
*E-mail: connief@arc.agric.za*

First ratoon (R1) sucker selection is one of the most critical operations in a banana plantation as it can strongly influence plant morphology and vigour. Banana tissue culture plants produce many suckers soon after field establishment. The first series of suckers to emerge are referred to as the “first flush” of suckers (up to 6 suckers). Early destruction of these suckers allows another group of suckers to emerge above ground and these are referred to as the “second flush” suckers (7 to 12 in sequence). Tissue culture banana plants (cv. Grand Nain) were established at Burgershall Research Station in December 1999 to determine the influence of selecting “first flush” suckers (1 to 6) and “second flush” suckers (7 to 12) on production potential. Treatments comprised 6 sucker selection stages from the first or second flushes. Results are tabulated on plant morphology and components of yield for 4 cycles. None of the first or second flush selection treatments had an influence on the productivity potential of the parent plant. Differences in plant vigour were only measured in the first ratoon (R1) crop cycle. Time of sucker selection had no effect on the bunch weights in any of the crop cycles. Highest annual yield (t/ha/an) in the R1 crop cycle was recorded with the early first flush selection due to a very short cycle from harvest of the parent crop to harvest of the ratoon 1. This cycle time advantage had a carry over effect in both the R2 and R3 crop cycles which meant the highest annual yield over all 4 cycles was from the first flush selection treatment. This information can be used to determine optimum R1 sucker selection times for summer and autumn planting dates.

*Keywords:* banana, *in vitro*, sucker management, yield potential

## 62. INVESTIGATION INTO THE LEACHING STATUS OF CUTANIC SUBSOILS

Prinsloo, HP and Schoeman, JL

ARC-Institute for Soil, Climate and Water, P Bag X79, Pretoria 0001, South Africa  
E-mail: jan@arc.agric.za

In the South African Soil Classification System, leaching status, as a diagnostic soil family criterion, is applied to soils with apedal subsoil horizons. Members of the National Soil Classification Working Group have suggested that leaching status be introduced as a family criterion in soils with cutanic horizons. The aim of the study was to investigate the occurrence and distribution of leached cutanic soils within South Africa. Through interrogation of the ARC-ISCW Climate Information System and the ARC-ISCW Land Type Information System in GIS, high rainfall areas associated with leached soils were identified. Representative profiles of cutanic soils were also overlaid from the ARC-ISCW Soil Profile Information System, and their leaching status calculated. This information was used to design a data collection process to provide soil samples for laboratory analyses. Database results indicate that 30 % of lithocutanic, 32 % of neocutanic, 14 % of pedocutanic and 7 % of prismaeutanic soils were leached. A combination of land type inventory and soil profile data indicates that leached cutanic soils cover approximately 1.8 million ha. This constitutes 1.5 % of the country as a whole and 9 % of the high rainfall areas. Of the new profiles described and sampled, 16 % of lithocutanic, 32 % of neocutanic, 6 % of pedocutanic and 45 % of prismaeutanic soils were leached. Altogether 20 % of cutanic soils were leached. Sample preparation may have a fairly dramatic effect on CEC and S values obtained, while the clay percentage was less affected. Due to several factors, *inter alia* spurious laboratory results to be expected if normal non-aggressive sample preparation is used, the added cost of laboratory analysis, and the need to retain simplicity in the South African Soil Classification System, it is not recommended that leaching status be introduced as a compulsory family criterion for cutanic soils, other than neocutanic, on revision of the system. As is the case with other important variable soil attributes, or soil attributes lacking in regularity or impact, *ad hoc* phases can be created to put the phenomenon on maps and records.

*Keywords:* cutanic subsoils, leaching status

### **63. THE INFLUENCE OF PARENT MATERIAL (GRANITE AND SCHIST) ON THE CHEMICAL AND PHYSICAL PROPERTIES OF SOILS ON SYFERKUIL EXPERIMENTAL FARM**

**Maribeng, L<sup>1</sup>, Vanassche, FMG<sup>2</sup>, Mashatola, B<sup>2</sup> and Barnard, RO<sup>1</sup>**

*<sup>1</sup>ARC-Institute for Soil, Climate and Water, P Bag X79, Pretoria 0001, South Africa;*

*<sup>2</sup>School of Agriculture and Environmental Sciences, Department of Soil Science and Remote Sensing, University of Limpopo, P Bag X1100, Sovenga 0727, South Africa*

*E-mail: maribengl@arc.agric.za*

The influence of parent material on physical and chemical properties of soil was studied on granite and schist parent materials on the University of Limpopo Experimental Farm, situated in the Mankweng area of the Limpopo Province of South Africa. The farm is subject to sub-arid climatic conditions, experiencing only summer rains. A total of 49 samples of virgin soils were collected, where granite soils constituted 26 samples and schist soils 23. The study design that was used is cross-sectional. The samples were analysed for physical and chemical properties. The physical properties of granite and schist soils were determined as % coarse sand, % medium sand, % fine sand, % very fine sand, % silt and % clay, whilst the chemical properties were determined as concentrations (mg/kg) of Na, Mg, Ca, K and P, as well as pH. Statistical analysis of the results was performed by application of the Unpaired Student's T Test, with the level of significance at  $p < 0.05$ . The results showed that soils derived from granite had significantly higher coarse and medium sand fractions than schist soils, whereas schist soils were significantly higher in fine sand, very fine sand, silt and clay. In terms of chemical analysis, schist soils showed higher values. The concentrations of Na, Mg, Ca, K and P, as well as the pH in schist soils were all significantly higher than in granite soils. However, the concentrations of nutrient elements were found to be insufficient for proper production in agriculture. It was concluded that both granite and schist soils can be used for agriculture with careful management because both soils indicated poor nutritional status.

*Keywords:* parent material, chemical properties, physical properties

## **64. INFLUENCE OF TERMITES ON SOIL GENESIS IN THE WESTERN AND NORTHERN CAPE PROVINCES OF SOUTH AFRICA**

**Ellis, F and Lambrechts, JJN**

*Department of Soil Science, Faculty of AgriSciences, University of Stellenbosch,  
P Bag X1, Matieland 7602, South Africa  
E-mail: fe@sun.ac.za*

In the Northern and Western Cape the harvester termite *Microhodotermes viator* is associated with large circular mounds called "heuweltjies". They have a huge influence on the soils found on them compared to the inter-heuweltjie areas. A direct relationship exists between different soils associated with the heuweltjies and climate, terrain, parent material and geomorphic age conditions. Heuweltjies are virtually absent on base-poor parent material (e.g. sandstone). Strikingly different soils and vegetation cover generally occur on and between heuweltjies. In the driest (MAR <150 mm) northern parts of Namaqualand and Little Karoo, hardpans are found in soils of heuweltjies as well as in soils between heuweltjies. On the other hand, in the highest rainfall areas (MAR >450 mm) of the South Western Cape, both heuweltjies and inter-heuweltjie soils are without a hardpan. Heuweltjie soils are however morphologically different and more base-rich than in soils between heuweltjies. In the 150-450 mm rainfall zone, investigations of heuweltjies and inter-heuweltjie soils indicated that the occurrence of heuweltjies might play an important role in the genesis of hardpan formation. On steep slopes, especially in the low-rainfall zones, structured B horizons (e.g. pedocutanic horizons) occur on the down slope side of the periphery of the heuweltjie. In stony areas the biomantle of heuweltjie soils are largely stone-free with stone-lines that occur at great depths (e.g. 150 cm). Heuweltjies can be seen as large biological "cities" where plant material in various stages of decomposition, collected by the termites, has build up over time. This has led to the build-up of bases (especially Ca) and silica over time. The termite activities have further resulted in mixing of the soil, settling out of stones to deeper depths, creation of a fairly well-drained material with a higher soil pH, preference of structural development in subsoils on periphery zones, compared to most of the surrounding areas.

*Keywords:* termites, soil genesis, heuweltjies



## **65. BASE-RICH “HUMIC” AND WETLAND SOILS IN THE LESOTHO HIGHLANDS**

**Schoeman, JL**

*ARC-Institute for Soil, Climate and Water, P Bag X79, Pretoria 0001, South Africa*

*E-mail: jan@arc.agric.za*

Two soil types that occur extensively in the Lesotho highlands are currently not well accommodated in the South African Soil Classification System. The first type is well-drained, organic matter-rich, dark loams or clay loams that are excluded from the South African humic concept by their high base status. A case is made for recognizing organic matter-rich families in selected orthic and melanic soil forms, considering their land use implications. The second type consists of deep, black loams occurring in wetlands and wetland fringes, but failing to meet the organic matter content criterion for organic soils. Mineral and organic wetland soils in the highlands, their classification and land use are discussed.

*Keywords:* soil classification

## **66. SWELLING PROPERTIES OF SELECTED SOIL HORIZONS**

**Turner, DP and Van der Walt, M**

*ARC-Institute for Soil, Climate and Water, P Bag X79, Pretoria 0001, South Africa  
E-mail: dturner@arc.agric.za*

Vertic soils are traditionally recognized by their well-developed characteristic morphological properties. They are defined as having a strongly developed fine ped structure, well-developed slickensides in the vertic horizon or in the transition to the underlying horizon, or a plasticity index exceeding 32 units. These soils exhibit pronounced swell – shrink properties, have a dominantly smectite clay mineralogy, a clay texture and commonly exhibit dark soil colours. They may also have large cracks when dry or a self-mulching surface. In the South African Soil Classification System they were recognized as topsoil horizons, and generally lack marked differences in morphological properties between the surface and subsurface horizons. Soils with similar morphological properties and with plasticity index values exceeding 32 units have been identified in certain subsoil horizons and are also noticed in soils previously classified into the melanic topsoil horizon. This paper investigates the extent of these soils within the South African Soil Classification System and their range in properties associated with soil swelling. The paper investigates the values for plasticity index, linear shrinkage, clay percentage, cation exchange capacity, pH and clay mineralogy (X-ray diffraction) for 2 800 soils within seventeen soil forms drawn from the ARC-ISCW Soil Information System. The paper reports on the threshold value for plasticity index of vertic soil horizons as derived from morphological observations (slickensides – the shiny, grooved soil surfaces) from profile descriptions and by statistical evaluation. Plasticity values, clay mineralogy and other soil properties are discussed in relation to the definitions of the South African Soil Classification System. The paper also reports on the extent of swelling properties in certain subsoil horizons, notably the pedocutanic and prismaeutanic B horizons and the gleyed G horizon, where swelling properties exceeding the threshold values could be exceeded in 30% of soils. Finally, the paper examines the application of the definition for vertic topsoil horizons in the South African Soil Classification System, and provides evidence to support a class at the family level for swelling properties in selected subsoil horizons.

*Keywords:* Swelling properties, plasticity index, soil classification

## **67. ALTERNATIVE ENVIRONMENTALLY FRIENDLY SOIL AMELIORATES**

**Ndala, SM, Mabuza, N and Malatsi, R**

*200 Hans Strydom Street, Randburg 2127, South Africa*

*E-mail: stemmern@mintek.co.za*

The use of locally available mineral resources for soil amelioration has been advocated for a number of decades now. This paper highlights the use of locally available resources for the production of SLASH. Slash is a low-cost soil ameliorant that results from a combination of sewerage sludge, flyash and burnt lime. Although the work around SLASH and its application in agricultural systems has been extensively carried out by Eskom and the University of Pretoria, the current initiative by Mintek aims to establish the scientific basis of the SLASH at the experimental site before full rollout to the areas around the experimental site.

The experiment is a randomized complete block design with three levels of SLASH application, one level of recommended dosage for commercial fertiliser currently in use by commercial farmers (3:2:3 NPK and lime) and a control with replication.

*Keywords:* slash, soil fertility, agricultural production

## **69. BIOSOLID COMPOSTING – PROCESS AND QUALITY PARAMETERS OF CERTAIN MUNICIPAL AND INDUSTRIAL BIOSOLIDS**

**Potgieter, JJC, De Jager, PC and Annandale, JG**

*Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002,  
South Africa*

*E-mail: jopot@tuks.co.za*

Biosolids produced by Water Care Works (WCW) are increasingly utilised in agriculture as a source of organic matter and plant nutrients. Composting is a means of biosolid stabilisation that produces a valuable and safe end product. This research aims to investigate and illustrate the specific requirements and conditions necessary for successful biosolid composting and propose strategies for monitoring and meeting these requirements and conditions. Furthermore, the compostability of biosolids of varying origins and stabilities is evaluated and compost quality determined. Three types of biosolids namely activated sludge from an industrial WCW, activated sludge from a domestic WCW and anaerobically digested sludge from a domestic WCW were composted with bluegum sawdust as bulking agent in four treatments. Feedstock materials were characterised in terms of water, carbon and nitrogen content and suitable mixing ratios calculated. Piles were mixed, turned and watered manually and pile temperature, volume and water content recorded. The water content of piles was kept between 50 and 69% (wet mass base) while maximum pile temperatures recorded were between 46 and 73°C. Observations indicative of composting were decreased pile volumes of between 16 and 41%, decreased pile dry mass of between 36 and 47%, lower dry bulk densities for all piles, slightly lower pH values and generally higher EC readings, increased ash content of between 4.7 and 8.7% and decreased C:N ratios from between 20 and 30 to between 14 and 19. The initial stability of biosolids influenced their performance during composting and treatments with more stable sludge resulted in lower organic matter decomposition and less heat generation. Data is also presented on cellulose and lignin degradation, humic and fulvic acid content (humification) and a variety of chemical, physical and biological characteristics. Chemical and biochemical characteristics of feedstock materials and composts provide insight into processes like humification and lignin degradation, as well as maturity and quality characteristics of biosolid composts.

*Keywords:* Biosolid stability, Composting, Compost quality, Humification, Lignin degradation

## **70. EVALUATION OF HUMAN URINE AS SOURCE OF NITROGEN IN THE CO-COMPOSTING OF PINE BARK WITH LAWN CLIPPINGS**

**Fatunbi , AO, Mnkeni, PNS and Brutsch, MO**

*Department of Agronomy, University of Fort Hare, P Bag X1314, Alice 5700,  
South Africa*

*E-mail: afatunbi@ufh.ac.za*

The introduction of urine diversion toilets has created opportunities for recycling nutrients in human urine for agricultural purposes. One of such possibility is to use it to replace urea fertilizer as source of nitrogen in the composting of pine bark. A composting experiment was set up with the following treatments: Pine bark + Lawn clippings (T1); Pine bark + Lawn clippings + Urea fertilizer (T2); Pine bark + Lawn clippings + Human urine (T3); Pine bark + Lawn clippings + Human urine + MgO + Single superphosphate fertilizer (SSP) (T4); and Pine bark + Lawn clippings + Human urine + MgO + Rock phosphate (RP) (T5). Composting was carried out in wooden boxes indoors for 84 days. Compost formation proceeded in all composting mixtures with temperatures as high as 65<sup>0</sup>C. The degree of degradation also increased with composting time in all treatments. There was a significant ( $P>0.01$ ) difference in the pH of the final composts: T1 was 5.56 while T2 was 4.96; this implied that co-composting pine bark with lawn clippings leads to reduced acidity compared with the use of urea fertilizer. Electrical conductivity was also significantly ( $P>0.01$ ) different among treatments: T3 had higher value compared to T1 and T2, which implied that application of human urine resulted in a more saline compost. The resulting composts were evaluated for their suitability as growing media for vegetable transplants using cabbage as test crop for four weeks. Cabbage biomass yield, tissue N, P and K content were significantly ( $P<0.01$ ) affected by both growing medium and fertilizer application. The cabbage biomass, tissue N, P and K were not significantly different between T1 and T2, which implied that co-composting of lawn clipping with pine bark alone will make mature compost that is suitable as a growing medium. Similarly the non-significant difference between T2 and T3 indicated that human urine could substitute for urea fertilizer in co-composting of pine bark and lawn clippings.

*Keywords:* Pine bark, Human urine, Lawn clippings , Composting, Struvite

## **71. MONITORING N AND P UPTAKE, NO<sub>3</sub> LEACHING AND HEAVY METAL UPTAKE OF MAIZE AND OATS IN SEWAGE SLUDGE AMENDED AGRICULTURAL SOILS**

**Tesfamariam, EH<sup>1</sup>, Annandale, JG<sup>1</sup>, Stirzaker, RJ<sup>2</sup>, Stockle, CO<sup>3</sup> and Steyn, JM<sup>1</sup>**

<sup>1</sup>*Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002, South Africa;* <sup>2</sup>*CSIRO Land and Water, PO Box 1666, Canberra 2061, Australia;*

<sup>3</sup>*Biological Systems Engineering Department, Washington State University, PO Box 646120, Pullman, Washington, USA*

*E-mail: s22363808@tuks.co.za*

Optimising the rate of sludge application in agricultural lands is crucial both from agricultural and environmental sustainability points of view. It is crucial from the 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 the 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 crop N and P uptake, heavy metal uptake, nutrient deficiency and nitrate leaching from dryland maize and irrigated maize/oat rotation. Each cropping system received three levels of sewage sludge, namely according to the existing norm of 8 ton ha<sup>-1</sup> a<sup>-1</sup>, half of that (4 ton ha<sup>-1</sup> a<sup>-1</sup>) and double the norm (16 ton ha<sup>-1</sup> a<sup>-1</sup>). The sludge treatments for the irrigated maize/ oat rotation and the 16 ton ha<sup>-1</sup> dryland maize 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 4 and 8 ton ha<sup>-1</sup> dryland sludge treatments all the sludge was applied at the beginning of the summer season (planting time). The total N uptake from the dryland maize treatments ranged between 169 – 172 kg ha<sup>-1</sup> and 24 – 38 kg ha<sup>-1</sup> P. However, the uptake was very high for the 16 ton ha<sup>-1</sup> a<sup>-1</sup> irrigated maize treatment, namely 492 kg ha<sup>-1</sup> N and 108 kg ha<sup>-1</sup> P. Similarly, oats utilized 250 kg ha<sup>-1</sup> N and 70 kg ha<sup>-1</sup> P. According to the leaf analyses for the 2005 summer season the level of N was adequate for all the dryland maize treatments. However, it was insufficient for the irrigated sludge treatments. During the winter of 2005, N and K deficiency was observed in the control, 4 and 8 ton ha<sup>-1</sup> sludge treatments. However, the P supply was adequate. The level of heavy metal uptake by the control was more or less similar to the 16 ton ha<sup>-1</sup> sludge treatments. The maximum concentration of NO<sub>3</sub> leachate below 30 cm soil depth was 21.1 mg l<sup>-1</sup> and this was observed in the 16 ton ha<sup>-1</sup> sludge treatment once at the beginning of the season. The concentration of NO<sub>3</sub> leachate decreased along the season.

*Keywords:* Sludge, nitrogen, phosphorus, NO<sub>3</sub>, heavy metals

## **72. THE EFFECT OF WATER AND NITROGEN AVAILABILITY ON THE YIELD AND WATER USE EFFICIENCY OF THREE SUB-TROPICAL PERENNIAL GRASS SPECIES**

**Marais, D and Rethman, NFG**

*Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002, South Africa*

*E-mail: diana.marais@up.ac.za*

Earlier trials with the same grass species resulted in higher yields with less water. The question was raised if this was not due to a lack of nitrogen. To test this, the effect of three levels of water availability and four levels of nitrogen on the yield and water use efficiency of three subtropical perennial grasses (*Cenchrus ciliaris*, a *Cynodon* hybrid and *Pennisetum clandestinum*) were evaluated in a pot trial. The three levels of water availability were: soil profile brought to 33 (W1), 66 (W2) and 100% (W3) of field capacity twice per week. The grasses also received four levels of nitrogen namely: N0 = 10 kg N ha<sup>-1</sup>, N1 = 80 kg N ha<sup>-1</sup>, N2 = 160 kg N ha<sup>-1</sup> and N3 = 280 kg N ha<sup>-1</sup>.

The *Cynodon* hybrid used significantly less water than *C. ciliaris*, but was able to produce significantly the highest yields in this trial. As was expected, the grasses tended to use more water and produce higher yields as the level of nitrogen was increased. All three grasses tended to produce higher yields at the N3 level than at the N0 level, despite restricted water supply. Where water availability is thus restricted, nitrogen should still be applied. Water use efficiency was improved with increased amounts of nitrogen, but was not significantly different at the N2 and N3 levels of nitrogen.

The root systems of all three grass species tended to be weaker under W1 than W2 and W3 conditions, with that of the *Cynodon* hybrid being the poorest. The root systems also tended to be stronger with N2 and N3 than with N0 and N1 levels of nitrogen, regardless of the amount of water applied.

Since the yields at the medium level (W2) of water availability did not differ significantly from yields at the high level (W3) of water availability, even at the high level of N availability, it can be concluded that it was not a lack of nitrogen causing the lower yields in the earlier trials. The grass plants may not be adapted to such high levels of water availability.

*Keywords: Cenchrus ciliaris, Cynodon hybrid, Pennisetum clandestinum, nitrogen, yield, water use efficiency*

### **73. EVALUATION OF THE EXTERNAL P REQUIREMENT OF TWO SOILS FROM THE TRANSKEI REGION, SOUTH AFRICA, UNDER GLASSHOUSE CONDITIONS**

**Gichangi, EM, Mnkeni, PNS and Muchaonyerwa, P**

*Department of Agronomy, University of Fort Hare, P Bag X1314, Alice 5700,  
South Africa*

*E-mail: s200435019@ufh.ac.za*

The use of sorption isotherms to determine phosphorus requirement is considered more accurate than conventional soil P tests. The availability of P to plants has been shown to be related to the P concentration in the soil solution and the soils ability to replenish or buffer the P concentration as P is removed by plants. A glasshouse experiment was conducted to evaluate the external P requirement of two soils with varying sorption properties from the Transkei region using oat (*Avena sativa L.*) as a test crop. Eight levels of P application estimated from the Langmuir equations that gave a range of P concentrations in the soil solution were evaluated. The rates were 0, 45, 90, 135, 180, 225, 270, and 315 mg P kg<sup>-1</sup> for Flagstaff soil and 0, 10, 20, 30 40, 50, 60, and 70 mg P kg<sup>-1</sup> for Qunu soil and these resulted in equilibrium soil solution concentrations of between 0 to 0.35 mg P l<sup>-1</sup> for both soils. The treatments were replicated four times in a randomized complete block design and harvesting was done 10 weeks after planting. Biomass yield and tissue P concentration was increased significantly ( $p \leq 0.05$ ) by addition of fertilizer P when compared with the control and the responses were curvilinear for both soils. Maximum biomass yield was achieved at an equilibrium P concentrations of 0.24 and 0.26 mg P l<sup>-1</sup> for Flagstaff and Qunu soils, but, the yield obtained from these concentrations were not significantly different from those obtained at a soil solution P concentration of 0.2 mg P l<sup>-1</sup> reported in the literature to be a threshold for many crops. The good relationships between equilibrium P concentration and biomass yield indicate the usefulness of P sorption approach for making fertilizer recommendations.

*Keywords:* Sorption isotherms, Langmuir equation , External P requirement, Biomass yield, Plant P-uptake



## **74. THE USE OF POT TRIALS TO DETERMINE SOIL COEFFICIENTS AND MAXIMIZE YIELD POTENTIAL**

**Smit, MA<sup>1</sup>, Khomo, B<sup>2</sup> and Koyi, S<sup>3</sup>**

<sup>1</sup>*South African Sugarcane Research Institute, P Bag X02, Mt Edgecombe 4300, South Africa;* <sup>2</sup>*ARC-Grain Crops Institute, P Bag X1251, Potchefstroom 2520, South Africa;*

<sup>3</sup>*ARC-Institute for Soil, Climate and Water, P Bag X79, Pretoria 0001, South Africa*  
*E-mail: michiel.smit@sugar.org.za*

Experiments were conducted at Mt Edgecombe to quantify the effect of three soil types (Inanda, Mayo and Dundee) on crop growth parameters. The soils were sampled at Bruynshill, Mt Edgecombe and Umkomaas respectively and enough soil brought to Mt Edgecombe to do a trial with four replicates in 20L pots (2004) and 80L ashbins (2005). The soils were fertilized based on soil analysis in order to eliminate possible nutritional deficiencies and treated with temik to eliminate the risk for nematode. Three cultivars were used for the trial namely N31, N37 and Nco376. Stalk extension rate and phyllochron was measured for the whole growing season (February to October). Soil and leaf samples (at 8 leaf stage) were taken for chemical analysis. At harvest the total dry mass, stalk dry mass, leaf area, and stalk numbers were measured and analyzed using REML analysis.

Results for the 2004 trial indicated significantly lower green leaf number and area, growth rate, stalk number and stool biomass ( $p=0.05$ ) for the Inanda when compared to the Dundee soil type. The ranking order for the growth performance of these three soil types were related to their ranking order for soil pH and leaf Mn and Si content. A Calmasil lime treatment was consequently included in the 2005 trial which successfully corrected the deficiency and eliminated the differences in growth and yield experienced the previous year.

Results indicate that pot trials offer an effective method to:

- a) compare soil types in terms of growth performance,
- b) find and quantify deficiencies, and
- c) determine soil coefficients that can be used to model crop performance.

*Keywords:* Soil type, Silicon, Plant biomass, Soil coefficients, Sugarcane, Leaf area

## **75. INVESTIGATION INTO THE SUITABILITY OF CEREALS FOR ETHANOL PRODUCTION IN THE WESTERN CAPE PROVINCE**

**Botes, WC and Roux, HS**

*Department of Genetics, Stellenbosch University, P Bag X1, Matieland 7602,  
South Africa  
E-mail: wcb@sun.ac.za*

Internationally the price of crude oil is on the rise. The South African government recently started to actively promote the production and use of biofuels. In the Western Cape Province Grain South Africa (GSA) recently launched a task team to investigate the viability of establishing a bioethanol production plant for the region. Such an initiative can help many cereal grain producers return to profitability, increase employment in rural areas, protect the environment by promoting the use of a renewable, cleaner burning energy source, and help in making South Africa less dependent on expensive imported crude oil. The proposed will consist of scale field testing of existing varieties (wheat and triticale) over the Western Cape Province's production areas. The outcome of this project will give producers and potential investors an idea of which cereals (and varieties) will be better suited, and indicate which production areas are economically more viable for ethanol production. The developed testing protocols will be disseminated to industry for future use to enable the establishment of breeding efforts focussed on cultivars for increased ethanol production. Wheat is often used in European grain distilleries, because it yields such a mild and smooth distillate. Early results generated indicate that the starch content of wheat is typically in the order of 60%, and if wheat contains more than 13% raw protein it tends to prove problematic during the fermentation process. Triticale has also been used in tested and the starch content is usually in the region of 65%, and typically leads to higher realized ethanol production than wheat.

*Keywords: wheat , triticale, bioethanol*

## **76. SUGAR CONTENT OF PAPAYA AS INFLUENCED BY TEMPERATURE AND GENOTYPE**

**Louw, AJ**

*ARC-Institute for Tropical and Subtropical Crops, P Bag X11208, Nelspruit 1200, South Africa*  
*E-mail: aart@arc.agric.za*

The sugar concentration of papaya is estimated by Brix. Fruit with a Brix of 10 and higher is regarded as sweet and below 9; the fruit taste bland and has a negative influence on consumer acceptance. Genotype x environmental interaction has to be considered in selecting for higher sugar concentrations. Temperature is one of the most important environmental factors influencing the Brix of papaya fruit. There is, however, a delayed effect in that the average Brix is correlated with the minimum temperature 14-weeks prior to the measurement. The effect of minimum temperature on the Brix of papaya fruit is most likely due to the severe effect of temperatures below 12°C on the growth of the papaya. A papaya fruit, unlike many other fruits, does not have large quantities of starches or acids that will be converted to sugars as the fruit ripens but most of the sugars are formed during the final weeks of ripening. The canopy size of the tree relative to the number of fruit on the tree at final fruit development, will determine the maximum Brix potential.

*Keywords:* Papaya, Brix, Breeding

## **77. AGRONOMIC EVALUATION OF GENOTYPES FOR THE SOUTH AFRICAN SUGARCANE INDUSTRY**

**Ramburan, S**

*South African Sugarcane Research Institute, Private Bag X02, Mount Edgecombe 4300,  
South Africa*

*E-mail: sanesh.ramburan@sugar.org.za*

The objective of this paper is to provide a synopsis of the variety evaluation programme at the South African Sugarcane Research Institute (SASRI). The foundation for the programme involves conducting variety trials throughout the sugarcane industry across different environments (soil types and agroclimatic zones) and management practices (cutting cycles, harvest age, ripener use, etc). Trial sites are strategically selected to address specific industry requirements regarding information on variety performance. Trials are either managed by growers who are supervised by SASRI extension officers (EOs), or are conducted on experimental farms. Relevant agronomic variables are determined at and prior to harvest before being statistically analysed.

Plot, and statistically analysed treatment data are fed into a Microsoft Access database. The efficiency of the variety evaluation program lies in the ease and speed of accessing specific variety information from the database. Queries are run based on stipulated criteria in order to extract specific variety performance data, which is routinely sent to growers, EOs and researchers, or used in scientific/popular publications. Data can be extracted from as far back as 1977 when the program was established. Information generated from the programme is conveyed to growers by means of SASRI's extension services, grower days, personal communication, as well as by regularly updated Information Sheets on all varieties. Articles are published in SASRI's triennial journal, "The Link" on variety performance in specific areas or regarding specific variety concerns within the industry.

The programme provides an invaluable contribution to the performance of the South African sugarcane sector. However, in order to remain applicable and progressive, regular evaluations of the programme are necessary. Opportunities to be fully explored include enhancing collaboration between the programme and more basic SASRI research and to continuously adapt the programme to new industry demands while maintaining continuity and consistency. This paper demonstrates the effectiveness of the variety evaluation programme and identifies areas of constraints and opportunities. The procedures and methods employed may be applicable to variety evaluation of other crops in South Africa.

*Keywords:* database, evaluation, variety

## **78. MY CANESIM: A MODERN INFORMATION SYSTEM FOR SUGARCANE FARMERS, EXTENSION AND RESEARCH**

**Singels, A**

*South African Sugarcane Research Institute, Private Bag X02, Mount Edgecombe 4300,  
South Africa*

*E-mail: abraham.singels@sugar.org.za*

The uptake of decision support for management and research of crop production has been disappointing, mainly because of their complexity. This paper reviews a new approach to developing and implementing decision support. The main features of the approach are (1) the use of state-of-the-art technology, (2) limiting users' exposure to system complexity, and (3) participation of users in system design and implementation.

The *My Canesim* system consists of a sugarcane model and an on-line weather database. The system uses basic field data, initially entered by the user via the Internet, to calculate the soil and crop status for each day of the growing season as the season progresses.

Farmers, extension staff, mill cane supply management and crop scientists contributed to the design of the web interface, the advice and the reports generated by the system. The system was implemented on two small-scale irrigation schemes in Pongola and Makhathini, South Africa. Irrigation advice and yield estimates are disseminated weekly to 40 farmers using cell phone text messages. Summaries for each scheme are faxed to three extension officers and to mill management. Reports containing detailed information such as current and future cane yield, sucrose content and soil water deficit could also be downloaded from the website.

Key challenges that were encountered and how these were overcome, as well as achievements in farming efficiency and capacity development are discussed. The potential of this approach (1) to improve other aspects of crop production management and (2) to support strategic and applied research, are explored.

*Keywords:* My Canesim, crop model, weather data, extension, decision support, irrigation

## **79. TOWARDS A SIMPLE VEGETABLE SEED VIGOUR MODEL**

**Modi, AT**

*Department of Crop Science, University of KwaZulu-Natal, P Bag X01, Scottsville,  
Pietermaritzburg 3209, South Africa  
E-mail: modiat@ukzn.ac.za*

Determination of seed vigour presents one of the major challenges in seed science and technology. Consequently, only a few seed vigour tests are used, for a limited number of crop species. This study examined responses to seed desiccation and temperature during imbibition as indicators of seed performance under laboratory and nursery conditions. Seed desiccation sensitivity was found to significantly influence seed germination and vigour. The effects of desiccation were found during seedling establishment. A statistical model to relate seed laboratory performance and seedling establishment in pepper and tomatoes was determined and tested on various vegetable species. It is proposed that the model could predict seed performance for the purposes of seed testing and for seedling production.

*Keywords:* vegetable seed, desiccation, temperature

## **80. A HOLISTIC APPROACH TO USING THE CIELAB COLOUR SYSTEM IN HORTICULTURAL RESEARCH**

**Alcock, CM and Bertling, I**

*Horticultural Science, University of KwaZulu-Natal, P Bag X01, Scottsville,  
Pietermaritzburg 3209, South Africa  
E-mail: charlew@venturenet.co.za*

Many studies of colour change in horticultural crops have used various colour groups as a ripeness index. Several of these series of colour groups are commonly used in the field as an indicator of time of harvest, for example in the tomato and citrus industries. More recently, the CIELAB colour system, which expresses colour in mathematical terms, has been used in such studies. However, the diverse nature of the approaches of different researchers to using this system indicates the need for a holistic approach that can be effectively applied to any crop involving colour change. This paper proposes a concept incorporating both visual evaluation and the CIELAB colour systems, which can be used in research and in industry. The colour change of each crop is represented by a continuous 'colour line' and its associated equation(s), rather than as separate colour groups. This basic 'colour line' can then be interpreted and other relationships investigated depending on the nature of the crop and the objectives of the research. The 'colour lines' for several crops were established and interpreted, and further relationships found in accordance with these results. The implications of these studies are discussed, with particular reference to colour change research in general.

*Keywords:* colour change, CIELAB, 'colour line'

## **81. AGROMET RISK MANAGEMENT THROUGH BLENDED WEATHER TECHNOLOGIES**

**Murthy, VRK**

*Department of Agronomy, ANGR Agricultural University, College of Agriculture,  
Rajendranagar, Hyderabad 500 030, India  
E-mail: vrkmurthy11@hotmail.com*

Human beings have been on the earth for long and were hunter-gatherers for 99.5 % of their existence, only domesticating plants and animals for nearly 0.5 % of their existence. However, humans are often mystified by the change and variability of weather, climate and seasons. Therefore, they developed some agrometeorological services and managed environments in which they lived by following environmentally friendly agricultural practices without significantly damaging local ecologies. A study conducted through the distribution of questionnaires and individual contacts in Andhra Pradesh, India, revealed that an Almanac known locally as "Panchanga" has been extensively used by 60 % of farmers for numerous generations for weather-based decision-making in agriculture. Further analysis indicated that 15 % of the farmers used their Indigenous Technical Weather Knowledge (ITK) for the same purpose. However, globally the current status of agricultural production, forestry, rangeland etc., is influenced by the events of increasing disasters, risks and uncertainties. This resulted in understanding and exploiting the agometeorological information for the benefit of these sectors to take counter measures and to reduce the negative impacts of these events.

Therefore, weather and climate data systems for agricultural activities have become a necessity to expedite the generation of products, analysis and forecasts to combat and evolve preparedness measures against natural disasters, risks and extreme events. Products and tools like satellite remote sensing, GIS, GPS etc., of contemporary science and information technology, have been providing newer dimensions to effectively monitor and manage these negative events. In the same above-mentioned study it was concluded that nearly 42 % of the farmers in the survey reported that the satellite imagery projected at the end of the National News of India at prime times every day provided a very good visual indication about rainfall occurrence. It is felt by the farmers and the scientists that such new generation technology must be used along with ITKs such as "Blended Weather Technologies" (BWTs) for more effective early warning alerts. It has been suggested that this is possible with the establishment of Farmers Field Schools only. Also, it was highlighted in the survey that 72 % of 300 farmers surveyed had favoured these schools as 52 % of the farmers still follow their ITKs to overcome the ill effects of climate change and risks in agriculture. Similarly, 88 % of the interested end users of the climate information suggested down-scaling of different ranges of weather forecast.

*Keywords:* Risk management, Blended Weather Technologies, Farmers Field Schools, Agrometeorological services, End users, Agrometeorology



## **82. BASIC PATCHING METHODS EMPLOYED IN THE ARC-ISCW CLIMATE INFORMATION SYSTEM**

**Potgieter, CJ**

*ARC-Institute for Soil, Climate and Water, P Bag X79, Pretoria 0001, South Africa  
E-mail: potgietercj@arc.agric.za*

A case study that illustrates five basic patching methods for the infilling of temperature station data is presented. This is done for different regions over South Africa to determine which patching method fares better over a specific region. Stations that have a full record of the daily maximum temperatures for a month were selected for this study. Three stations were selected per region to be patched individually. In each of these cases, it was assumed that no data exists for the specific station to be patched. The data of the surrounding stations was then used to patch the missing data of the target station. The patching methods utilized in this study are all based on weighted averages, except for the most basic method (method 1), where simple averaging is used. The second and third methods deal with weighted averages. In method 2 the weight of each interpolation station is determined by the sum of the distances of the remaining interpolation stations away from the target. In method 3, the weight of each interpolation station is determined by the sum of the squared distances of the remaining interpolation stations away from the target. Methods 4 and 5 differ from the previous methods in the sense that the weight of each interpolation point is directly determined by its proximity to the target. In method 4 a Gaussian weighting scheme is used, whilst method 5 used a modification of the Gaussian weighting scheme proposed by Rautenbach. In the latter method the weight of each interpolation point is determined not only by its own proximity to the target, but also by the density of interpolation stations around the target.

To compensate for the altitude differences between the target and interpolation stations, the temperature values of the interpolation stations were adjusted. This temperature adjustment is achieved by moving dry adiabatically from the height of the interpolation station to the height of the target station. After making the temperature adjustment, each of the five methods was applied again to interpolate to the target. An improvement was observed in the results after the temperature adjustment was implemented. Overall, the method proposed by Rautenbach provided the best results, before and after the implementation of the temperature adjustment.

*Keywords:* Climate Information System

## **84. UPLAND COTTON (*GOSSYPIUM HIRSUTUM*) FIBER QUALITY RESPONSE TO DROUGHT: PRELIMINARY RESULTS**

**Ngobeni, HM<sup>1</sup>, Labuschagne, MT<sup>2</sup>, Cornelissen, APF<sup>3</sup> and Mabula, LG<sup>3</sup>**

*<sup>1</sup>ARC-Vegetable and Ornamental Plant Institute, P Bag X293, Pretoria 0001, South Africa; <sup>2</sup>Department of Plant Sciences, University of the Free State, PO Box 339, Bloemfontein 9300, South Africa; <sup>3</sup>ARC-Institute for Industrial Crops, P Bag X82075, Rustenburg 0300, South Africa  
E-mail: ngobenim@arc.agric.za*

Numerous traits contribute to drought tolerance in cotton. Only limited breeding effort has been expanded on identifying or combining such traits. Field screening with different water regimes can be used to induce stress at different stages of growth. Improved drought tolerance of upland cotton varieties through breeding would be a major contribution to increasing or stabilizing cotton production. The objective of this study was to determine the response of fiber quality (fiber length, uniformity, elongation, strength, Short Fiber Index (SFI), and micronaire) to drought. Twelve cotton varieties were evaluated at the ARC-IIC, Rustenburg, South Africa. A split plot design, with three replications, was used. The main factor (plot) was assigned to two types of irrigation namely rainfed and irrigated conditions, and the 12 upland cotton varieties were sub factors, simulating rainfed farming induced drought effects. Planting in the field was done early November 2005 and five seeds per hill were planted 2.5-5.0 cm deep. Rainfall started late November 2005 at a low rate and this affected seed germination, but rain increased later. Therefore no drought was experienced during the growing season at flowering stage. Irrigation types influenced uniformity, elongation, and strength of fibres statistically, whereas for fiber length, SFI and uniformity no significant differences were detected among the varieties. Micronaire, and SFI were influenced by interaction of irrigation and varieties.

*Keywords:* Rainfed conditions, Irrigated conditions, Upland cotton varieties

## **85. RESPONSES OF TEA PLANTS AND CLONES (CAMELLIA SINENSIS) TO SLOPE AND PHYSICAL SOIL FACTORS IN SOUTH AFRICA**

**Nethononda, LO<sup>1</sup> and Laker, MC<sup>2</sup>**

<sup>1</sup>*Madzivhandila College of Agriculture, P Bag X504, Thohoyandou 0950, South Africa;*

<sup>2</sup>*477 Rodrick Road, Lynnwood 0080, Pretoria, South Africa*

*E-mail: nethononda@yahoo.com*

The study was conducted in six tea growing areas of South Africa. Survey questionnaires were distributed to all six tea growing areas and were filled by field managers who gave their observation of the responses of different tea plants and clones to slope and soil physical factors. Four of the six tea growing areas had tea planted from seedlings and only Mambedi and Mukumabi Tea Estates had tea clones. Topographical factors, such as slope aspect, affected the growth and yield performance of tea clones at different locations under field conditions. At Mambedi river, the clones that were sensitive to north-facing slopes were BB 35, TRI 6/8, MT 12, SFS 204, SFS 150, PC 81 and PC 1. At Grenshoek the estate manager indicated that clones such as SFS 204 and PC1 were sensitive to north-facing slopes. The sensitivity of tea plants to north-facing slopes was also reported by the estate manager at Middelkop. Soil physical factors were such as depths and texture found to be a limiting factor to tea on all the six estates except Tshivhase. Tea plants and all clones in general were sensitive to north-facing slopes than to south-facing slopes and performed poorly where soil conditions were poor.

*Keywords:* Tea, plants, clones, soil, slope , aspect

## **86. EFFECT OF TEMPERATURE ON THE GROWTH OF TARO (*COLOCASIA ESCULENTA*)**

**Mare, RM and Modi, AT**

*Department of Crop Science, University of KwaZulu-Natal, P Bag X01, Scottsville,  
Pietermaritzburg 3209, South Africa  
E-mail: maphokamare@yahoo.com*

The influence of three day/night temperature regimes (22/12°C, 27/17°C and 33/23°C) was determined on the growth of five taro landraces: *Dumbe-dumbe*, *Mgingqeni*, *Pitshi*, *Pitshi-omhlophe* and *Dumbe-lomfula*. Plants were grown in glasshouses for nine months and emergence was determined daily until all plants had emerged. Leaf number, plant height and leaf area were determined every month. For all landraces, time to emergence increased significantly with decrease in temperature from 33/23°C to 27/17°C but it increased significantly for only *Dumbe-dumbe* and *Mgingqeni* from 27/17°C to 22/12°C. *Mgingqeni* showed the shortest time to emergence, whereas, *Pitshi* showed the longest delay in emergence. Leaf number was highest for *Pitshi-omhlophe*, due to its tendency to produce multiple shoots compared with the other landraces. Plant height increased with increase in temperature for all landraces except for *Pitshi*, for which height decreased with an increase in temperature. Leaf area was greatest for *Dumbe-lomfula* at all temperatures and lowest for *Pitshi* at both 22/12°C and 27/17°C. The highest total number of corms was shown by *Pitshi-omhlophe* at 22/12°C. Total fresh corm weight was highest for *Dumbe-lomfula* at 27/17°C and lowest for *Pitshi* at 22/22°C. The results of this study indicated that taro plant growth is enhanced by high temperatures. High temperatures are associated with short leaf area duration and subsequently low yield.

*Keywords:* Growth , taro landraces, temperature, yield

## **87. EFFECTS OF CALCIUM CONCENTRATION IN THE POD CULTURE SOLUTION ON CALCIUM AND POTASSIUM FLUXES OF DEVELOPING GROUNDNUT (*ARACHIS HYPOGAEA* L.) PODS**

**Zharare, GE<sup>1</sup>, Blamey, FPC<sup>2</sup> and Asher, CJ<sup>2</sup>**

<sup>1</sup>*Department of Agriculture, University of Zululand, P Bag X1001, KwaDlangezwa 3886, South Africa;* <sup>2</sup>*School of Land and Food Sciences, The University of Queensland, Queensland 4072, Australia*  
*E-mail: gzharare@pan.uzulu.ac.za*

In addition to receiving mineral nutrients from the roots via the long distance transport, developing pods of groundnut (*Arachis hypogaea* L.) have been shown to partake in direct uptake of mineral nutrients from the soil. Some recent studies on nutrient fluxes of the developing groundnut pod have, however, shown that developing groundnut pods have a net potassium (K) efflux. The K efflux may drive Ca uptake by the pods through a counter flux mechanism. Two solution experiments were conducted to investigate Ca and K fluxes of developing groundnut pods in three cultivars; viz Virginia bunch strain 1 (Virginia), TMV-2 (Spanish) and CBR4 (Valencia). The first experiment (pod-zone Ca experiment) investigated the effects of Ca concentration (0, 5, 25, 11, 525, and 2500  $\mu\text{M}$  added as the sulphate salt) in the pod culture solution (containing 0.5  $\mu\text{M}$  Zn and 4  $\mu\text{M}$  Fe) on Ca and K fluxes of developing pods over a 24 hour period in three groundnut cultivars. The second experiment (pod-zone K experiment) investigated the effects of K concentration (0, 10, 100 and 1000  $\mu\text{M}$  added as the sulphate salt) in the pod zone on Ca and K fluxes of developing pods. In all three cultivars, there was a net Ca influx whose magnitude increased with increasing Ca concentration in the pod solution. By contrast, all three cultivars showed a net K efflux from their pods in all pod-zone Ca and K treatments. In the pod-zone Ca experiment, the magnitude of K efflux increased with Ca concentration of the pod solution and was positively correlated with net pod Ca influx. In the pod-zone K experiment, the concentration of K in the pod culture solution did not affect both the net Ca influx and K efflux of the pods. In both experiments, the sizes of the Ca and K fluxes differed with the groundnut cultivars. The results of the study suggest that developing groundnut pods do not absorb K directly from the soil and therefore K may not be antagonistic to pod Ca absorption by groundnut pods. Rather, Ca influx into developing groundnut pods may be closely linked to pod K efflux.

*Keywords:* Ca influx, developing groundnut pods, K efflux, solution culture

## **88. ESTIMATING SUNFLOWER NITROGEN FERTILIZATION RATES WITH THE DELTA YIELD APPROACH**

**Nel, AA<sup>1</sup> and Bloem, AA<sup>2</sup>**

*<sup>1</sup>ARC-Grain Crops Institute, P Bag X1251, Potchefstroom 2520; <sup>2</sup>North West Department of Agriculture, Conservation and Environment, P Bag X804, Potchefstroom 2520, South Africa  
E-mail: nela@arc.agric.za*

Sunflower nitrogen fertilization recommendations are currently based on yield goals. In this approach, soil nitrogen supply is not taken into account with the result that nitrogen fertilization recommendations from different institutions are in disagreement. Other approaches have limited applicability under South African conditions. The nitrogen balance approach used in Argentina and the “Heliotest” procedure used in France, are both applicable only when the yield exceeds 2300 and 2000 kg ha<sup>-1</sup> respectively. Most of our local sunflower yields are below 2000 kg ha<sup>-1</sup>. Delta yield, the difference between a well fertilized crop and a zero nitrogen fertilized control, was found to be a more reliable indicator of the economic optimum nitrogen rate for maize than the yield goal, in three different countries applicable over the whole range of possible yields. In seeking improved accuracy, this study was done with the aim to develop and compare the delta yield procedure with the yield goal procedure for estimation of the economical optimum nitrogen fertilization rate for sunflower. Reported results of fifty fertilization trials done since the nineteen sixties in South Africa, each representing a specific year and locality, were collected. Nitrogen response curves were fitted and the optimum nitrogen rates, corresponding yields and delta yields calculated.

Grain yield responded to applied nitrogen significantly in only twenty-five of the trials and with the calculated optimum nitrogen rate within the limits of the applied nitrogen. Only 27% of the variation in the optimum nitrogen fertilization rate was explained by yield goal compared to 87% by delta yield, making it a far more reliable procedure for estimation of the optimum nitrogen rate. The relationship between delta yield and the optimum nitrogen rate is best described by a power function:

$Y = X^{0.669}$  with Y the optimum nitrogen rate and X the delta yield, both measured in kg per ha.

*Keywords:* Delta yield, nitrogen fertilization, sunflower

## **89. EFFECT OF FERTILISER PRACTICES ON DRYLAND GROUNDNUTS**

**Naane, GG and Seobi, T**

*North West Department of Agriculture, Conservation and Environment, P Bag X804,  
Potchefstroom 2520, South Africa  
E-mail: gnaane@nwpg.gov.za*

A project was started at Morokweng, near Vryburg, where there was a concern about low crop yields, especially groundnuts. The area of the project has low rainfall (390 mm/annum) and deep sandy soils ( $\pm 8\%$  clay in the top soil). The project is aimed at testing effects of Rhizobium and P solubilising inoculants and rotation with fertilised or unfertilised maize crop on groundnuts crop and on soil N and P in this agricultural production area. Crop yields could not be measured for the 2003/2004 season, but measured for the 2002/2003, 2004/2005 and 2005/2006 seasons. Relevant plots were planted to maize during the 2002/2003 and the 2005/2006 seasons, while all plots were planted to groundnuts in the 2004/2005 season. The seven treatments were control, that is, groundnuts without fertiliser, inoculants or rotation (GO); groundnuts with NPK fertiliser (GNPK); groundnuts with Rhizobium inoculant [G(Rhiz)]; groundnuts with P-solubiliser inoculant [G(P-Sol)]; groundnuts with combination of Rhizobium and P-solubiliser inoculants [G(Rhiz+P-Sol)]; maize with NPK fertiliser in rotation with unfertilised groundnuts (MNPk-GO); and maize without fertiliser in rotation with unfertilised groundnuts (MO-GO).

Long-term, three seasons of rotation, the unshelled groundnuts yield for GNPK treatment was 0.97 t/ha, and MO-GO, GO and MNPk-GO treatments were 23 % higher; while G(Rhiz), G(P-Sol) and MO-GO treatments were 43 % higher than the GNPK treatments. Long term, for the two growing seasons of measurement, groundnuts hay yield for MNPk-GO and MO-GO were 0.53 t/ha, while G(P-Sol), G(Rhiz) and GO treatments were 18 % higher and GNPK was 60 % higher. Long term groundnuts fertiliser treatment (GNPK) had the lowest unshelled groundnuts yield, but highest groundnuts hay yield (average total of 2.33 t/ha). The long term maize grain yield, over two rotation seasons where maize was included, had MNPk-GO treatment being 60 % higher than the MO-GO, from the baseline yield average of 1.12 t/ha. Long-term, across the three seasons, had MO-GO with the highest soil  $\text{NO}_3\text{-N}$  (2.53 mg/kg), while GO had the lowest  $\text{NO}_3\text{-N}$  (1.54 mg/kg). The inoculation treatments [G(Rhiz+P-Sol) and G(Rhiz)] did not differ from the treatments with the long term highest and lowest  $\text{NO}_3\text{-N}$  having an average of 1.68 mg/kg. Long-term, across the three seasons, had GNPK with the highest soil P (3.4 mg/kg), while G(P-Sol) had the lowest P (1.5 mg/kg). G(Rhiz+P-Sol) had the second highest soil P (3.3 mg/kg), followed by G(Rhiz), GO and MO-GO (2.2 mg/kg), and MNPk-GO (1.6 mg/kg).

G(Rhiz+P-Sol) had both the highest unshelled groundnuts and groundnuts hay (average total of 2.72 t/ha), and MNPk-GO had 60% more yield than MO-GO. The N-fixing Rhizobia might interfere with P movement, to plant or deeper within the soil; while rotation with maize might enhance this movement.

*Keywords:* Inoculants, Rhizobium, P-solubiliser, Groundnuts, Maize

## **90. EFFECTS OF MAGNESIUM CONCENTRATION IN THE POD CULTURE SOLUTION ON MAGNESIUM, CALCIUM AND POTASSIUM FLUXES OF DEVELOPING GROUNDNUT (*ARACHIS HYPOGAEA* L.) PODS**

**Zharare, GE<sup>1</sup>, Asher, CJ<sup>2</sup> and Blamey, FPC<sup>2</sup>**

<sup>1</sup>*Department of Agriculture, University of Zululand, P Bag X1001, KwaDlangezwa 3886, South Africa;* <sup>2</sup>*School of Land and Food Sciences, The University of Queensland, Queensland 4072, Australia*  
*E-mail: gzharare@pan.uzulu.ac.za*

Although a soil magnesium (Mg) level in excess of that of calcium (Ca) is known to adversely affect groundnut (*Arachis hypogaea* L.) pod development and filling, there is no direct evidence of Mg antagonism on Ca uptake by groundnut pods in the literature. Therefore, a solution culture experiment was conducted in a glasshouse to examine the effect of Mg (0, 10, 100, 1000  $\mu\text{M}$  supplied as the sulphate salt) in the pod culture solution (containing ca. 101  $\mu\text{M}$  S, 100  $\mu\text{M}$  Ca, 0.5  $\mu\text{M}$  Zn and 4  $\mu\text{M}$  Fe) on Ca absorption by developing pods in three groundnut cultivars; viz Virginia Bunch strain 1 (Virginia), TMV-2 (Spanish) and CBRR4 (Valencia). There was a net Mg influx into pods from all solutions that contained Mg. The net Mg influx increased as the solution Mg concentration increased, and this was accompanied by increasing alkalization of the pod culture solution and decreasing Ca influx into the pods. At the highest Mg concentration (1000  $\mu\text{M}$ ) tested in the pod culture solution, there was a net Ca efflux from the pods. In all three cultivars studied, a net pod K efflux was present in all Mg treatments, and the concentration of Mg in the pod solution had relatively little effect on net K efflux. The concentration of Mg in the pod shells and kernels as well as the concentration of S in the shells increased strongly with increasing Mg and S concentration of the pod culture solution. This was accompanied by decreasing Ca and Zn concentration in the pod shells and kernels. There were cultivar differences in Mg, Ca and K fluxes as well as in the concentrations of Mg, Ca and Zn in shells and kernels. The results confirm that Mg is antagonistic to Ca absorption by developing groundnut pods, and in the process may decouple Ca influx from K efflux resulting in alkalization of the pod-zone. Furthermore Mg was antagonistic to Zn uptake by groundnut pods.

**Keywords:** calcium, developing groundnut pods, magnesium, potassium, solution culture



# **91. THE EFFECT OF CYANOBACTERIA STRAIN 9V ON MAIZE GROWTH AND NITROGEN DYNAMICS OF DEGRADED GUQUKA AND HERTZOG SOILS OF THE EASTERN CAPE PROVINCE OF SOUTH AFRICA**

**Maqubela, MP<sup>1</sup>, Mnkeni, PNS<sup>1</sup> and Pardo, MT<sup>2</sup>**

*<sup>1</sup>Department of Agronomy, Faculty of Science and Agriculture, University of Fort Hare, Alice 6700, South Africa; <sup>2</sup>Consejo Superior de Investigaciones Cientificas, Centro De Ciencias Medioambientales, Serrano, 115dpdo – 28006 – Madrid, Spain  
E-mail: s9038648@ufh.ac.za*

Some cyanobacteria strains are known to have bio-fertilization effects in soil as a result of their ability to fix nitrogen. There is, however, little or no documented information on these effects in South Africa. This preliminary study was therefore carried out to evaluate the effect of a Tanzanian cyanobacteria strain 9v (a *Nostoc*), with or without cropping, on soil N in Guquka (Typic Plinthustalf) and Hertzog (Typic Haplustalf) soils from the Eastern Cape Province, under glasshouse conditions. Uptake of N by maize grown in this experiment was also evaluated. The treatments were arranged in a split split-plot design with soils as main plots, cropping (cropped vs non-cropped) as sub plots and inoculation (with and without cyanobacteria) as sub sub-plots. The cyanobacteria suspension was uniformly applied to potted soils soon after maize emergence to provide an equivalent dry biomass of 6g/m<sup>2</sup>. The experiment took six weeks after which plants were harvested and soils sampled and analyzed for total and inorganic N. Total nitrogen in the soils increased from 0.042 to 0.053 % as a result of inoculation. Inoculation of the soils increased nitrate N from 3.82 to 6.13 mg/kg. The increase in nitrate N was significant on Hertzog and not on Guquka soil probably because of good establishment of 9v on the Hertzog soil. Inoculation of the soils did not have an effect on ammonium N. Maize dry matter increased from 5.30 to 7.37 g/pot on the Guquka soil, and from 8.14 to 12.13 g/pot on the Hertzog soil as a result of inoculation. Tissue N increased from 0.59 on non-inoculated to 0.700 % on inoculated Hertzog soil but there was no effect of inoculation on tissue N of maize grown on Guquka soil. Cyanobacteria has a potential to improve fertility status of degraded soils in the Eastern Cape.

**Keywords:** Degraded soils, Cyanobacteria, Dry matter, Tissue N, Total and inorganic N

## **92. USE OF PRE-HARVEST MINERAL CONTENT OF SUBTROPICAL FRUIT AND NUTS TO MANAGE THE POST-HARVEST QUALITY AND STORAGE POTENTIAL OF THE CROPS**

**Kruger, FJ**

*ARC-Institute for Tropical and Subtropical Crops, P Bag X11208, Nelspruit 1200, South Africa*

*E-mail: fransk@arc.agric.za*

Subtropical export crops are afflicted by a wide range of physiological disorders. Although the symptoms emerge during storage, the causes are often of a pre-harvest nature. Three causative factors seem to be of particular importance. These are harvest maturity, climate and horticultural practices such as nutrition and irrigation. During the last decade, the Postharvest Section of the ARC-ITSC has done considerable research into the pre-harvest causes of certain physiological disorders of avocados, mangoes, citrus and macadamias. One of the most important investigative techniques involved monitoring the N, P, K, Ca, Mg, Zn, Cu, Mn, Fe & B content of the skin, pulp and kernel of the different crops during the maturation process.

A number of interesting trends were found to be shared by the different crops. For instance, the Mn content of the skin of mangoes and the kernels of macadamia fruit increased in cases of, respectively, lenticel damage and kernel discolouration. On the other hand, Fe exhibited complex patterns in so far as rind pitting of citrus and chilling injury of avocados is concerned. However, in all the above cases, it would seem that the disorders are not deficiencies or toxicity symptoms. It would rather appear that the climatic conditions that influence the translocation of the elements also cause the various disorders. In other cases, for instance Ca-associated end-of-season skin senescence in avocados, the disorder is brought about by a deficiency that, in turn, is caused by weather patterns. Of all the elements, the N content of the fruit proved to be the most important. In all cases, over-fertilization with N proved to be deleterious. In three of the crops (mangoes, avocados and citrus) small experimental dosages of N were also applied towards the end of the season. One of the aims of this was to simulate and amplify the N precipitation that occurs naturally. In most cases these applications increased the incidence and intensity of the disorders, while in isolated cases they reduced the symptoms. The N applications also had an interesting effect on the pulp and skin concentrations of some of the above mentioned micro elements.

*Keywords:* subtropical crops, postharvest quality

### **93. FRUIT SIZE AND YIELD EFFECTS OF TIME AND SEVERITY OF HAND THINNING ON 'NULES' CLEMENTINE MANDARIN**

**Verreynne, JS**

*Citrus Research International and Department of Horticultural Science, University of Stellenbosch, P Bag X1, Matieland 7602, Stellenbosch, South Africa  
E-mail: sv@cri.co.za*

Although hand thinning is a common practice in deciduous fruit production, not many citrus growers make use of this practice. This is possibly due to previous results indicating that a large proportion of fruit need to be removed in order to affect fruit size positively. The objective of this study is to evaluate the time and severity of hand thinning on yield and fruit size. Hand thinning can be done by removing blemished fruit and small fruit that would not attain exportable size at an early stage. In this study hand thinning of fruitlets of 'Nules Clementine' mandarin trees was done over three years in early January, end of January and mid February after physiological fruit drop at different severities by varying the size of the fruitlets removed. Hand thinning increased the average fruit size per tree by removing the smaller fruit, but had no effect on fruit growth of the remaining fruit on the tree. Although severe fruit thinning ( $\geq 32\%$  fruit removed) reduced or had no effect on yield (kg/tree), hand thinning did not reduce the marketable yield (fruit  $>55\text{mm}$ ) per tree.

*Keywords:* mandarin, hand thin, yield, fruit size

## **94. EXTENDED STORAGE TRIALS WITH SOUTH AFRICAN AVOCADOS**

**Lemmer, D, Malumane, TR, Ntandane, J and Kruger, FJ**

*ARC-Institute for Tropical and Subtropical Crops, P Bag X11208, Nelspruit 1200, South Africa*

*E-mail: daniel@arc.agric.za*

Extended storage of South African avocados at the end of the season will be of great benefit to local pre-packers, as it will reduce the need to import fruit from the northern hemisphere production areas during the South African off-season. The current study is a continuation of pilot trials initiated during 2004 and 2005, and aim to establish for how long South African avocados can be stored when combining SmartFresh™ with controlled atmosphere (CA).

During the 2005 season, two long term (6 month) storage trials were performed, one with Fuerte (moisture content 68%) and the other with Hass (moisture content 68%). The fruit were treated with Prochloraz (250ml/100l) and waxed. After this, SmartFresh<sup>SM</sup> was applied at the commercial dosage as well as at two higher dosages. The fruit were then stored under controlled atmosphere (CA) conditions (6% CO<sub>2</sub> and 4%O<sub>2</sub>) as well as under regular atmosphere.

From the results it would appear that it is possible to store good quality Fuerte avocado fruit for at least 2 months, while Hass can be stored for three months, when combining Smartfresh™ and CA. After this, physiological and pathological disorders start to develop. Of the two, fungal infections were most limiting. Upgrading the fungicide treatment, therefore, received special attention during the 2006 trials. Another potential avenue of research concerned the use of a fungicidal controlled atmosphere. These trials are currently running and account will be given on the results obtained.

*Keywords:* Extended storage, Post-harvest treatments, Controlled atmosphere, SmartFresh

## **95. THE FEASIBILITY OF HOT WATER TREATMENT OF 'HASS' AVOCADOS IN SOUTH AFRICA**

**Blakey, R and Bower, JP**

*Horticultural Science, University of KwaZulu-Natal, P Bag X01, Scottsville,  
Pietermaritzburg 3209, South Africa  
E-mail: 203502804@ukzn.ac.za*

South African avocados are mainly sold in Europe. However, this market is becoming increasingly competitive, with potentially declining revenues. New markets are therefore being sought. However, many of these markets have phytosanitary restrictions. The mitigating treatments likely to be accepted, involve cold sterilization, at temperatures close to or even below zero. Avocado fruit are usually considered chilling sensitive. Therefore, treatments to reduce the potential for chilling injury are needed. Previous work in showed that a hot water dip could prevent chilling injury. However, this has not been successfully repeated. It is not known whether cultivar, treatment temperature, fruit origin or maturity have influenced the results. The objective of the work was to investigate the use of hot water treatments on the cultivar Hass, so as to indicate the feasibility of such treatments, taking chilling injury, as well as fruit ripening characteristics into account. Fruit from two sources, Limpopo Province and KwaZulu-Natal were used, with three maturity (based on harvest time) states of the Limpopo fruit and one from the later maturing KwaZulu-Natal being used. Fruit were subjected to hot water treatments of 36, 38, or 40<sup>0</sup>C for 5, 15 or 30 minutes, before being stored at either 1 or 5.5<sup>0</sup>C for 30 days. After removal, fruit were checked for chilling injury, before being allowed to ripen, after which they were again checked for internal and external defects, days taken to ripen and mass loss (assumed to be water) during storage and ripening. Hot water treatments appeared effective in reducing chilling injury, postharvest disease and variation in the days to ripen. The most effective treatment appeared to be 38<sup>0</sup>C for 15 minutes. Fruit colour development (particularly of early season fruit) was enhanced by hot water treatment. Fruit maturity appears to play a role, with lower temperatures required for effect later in the season. The results also suggest that fruit quality modeling may be possible.

*Keywords:* Avocado, hot water treatment, chilling injury

## **96. UNDERGRADUATE EDUCATION IN HORTICULTURE IN SOUTH AFRICA**

**Du Toit, ES, Barry, GH, Bower, JP, Crouch, EM, Du Plooy, I, North, M, Sippel, AD, Soundy, P and Steyn, WJ**

*Southern African Society for Horticultural Sciences (SASHS), Department of Horticultural Science, University of Stellenbosch, P Bag X1, Matieland 7602, South Africa*

*E-mail: elsa.dutoit@up.ac.za*

The first SASHS workshop on undergraduate education in horticulture was held during the SASHS conference in Stellenbosch, 29 May 2006. The aim of the workshop was to provide a platform for representatives from industry, research institutions and tertiary education institutions currently offering horticultural courses, to debate and strategise the future of Horticultural Education in Southern Africa, keeping in mind the global trend in the decline of undergraduate student numbers. This presentation will highlight the current status of horticultural education in South Africa and challenges that need to be met in order to ensure the future of undergraduate education in horticulture.

## **97. APPLICATION OF THE IN-FIELD RAINWATER HARVESTING TECHNIQUE IN RURAL COMMUNITIES IN SOUTH AFRICA TO FIGHT POVERTY AND FOOD INSECURITY**

**Botha, JJ<sup>1</sup>, Anderson, JJ<sup>1</sup>, Groenewald, DC<sup>2</sup>, Joseph, LF<sup>1</sup>, Nhlabatsi, NN<sup>1</sup> and Van Rensburg, LD<sup>3</sup>**

*<sup>1</sup>ARC-Institute for Soil, Climate and Water, P Bag X01, Glen 9360, South Africa;  
<sup>2</sup>Department of Sociology, University of the Free State, PO Box 339, Bloemfontein 9300, South Africa; <sup>3</sup>Department of Soil, Crop and Climate Sciences, University of the Free State, PO Box 339, Bloemfontein 9300, South Africa  
E-mail: bothac@arc.agric.za*

Poverty and food insecurity are generic to the rural communities of poor countries in the sub-Saharan African region. South Africa, with its huge rural population is not excluded from the adversity of poverty. A recent socio-economic survey in Bloemfontein's Thaba Nchu district showed that the average consumption expenditure for a household is R278 per month. The equivalent poverty threshold for a household in the Free State that comprises 5 members (including 3 adults) is R711 per month. These figures indicate that most households are living below the poverty line, which in 1999 was estimated at R480. There is, therefore, a need to put in place measures that will contribute towards increasing household food and/or income. An in-field rainwater harvesting (IRWH) technique developed by the ARC-ISCW was tested for seven years on-station at Glen, and on-farm at Thaba Nchu and Botshabelo, east of Bloemfontein, where some 800 000 ha have been earmarked for developing farmers. The study area can be characterized as being semi-arid, with an annual rainfall of 550 mm and a potential evaporation of 2 244 mm. Soil crusting further aggravates water losses through runoff, which could be as high as 40 % on bare soil. The aim of the study was to demonstrate and implement the application of IRWH in rural villages in the quest for farmers to fight food insecurity and poverty. The outcome has been remarkable as more than 1 000 households from 42 villages and one trust farm have employed the technique successfully. During the first year of application, the farmers have already experienced the benefit of IRWH in terms of increased crop yields (i.e. more food) and increased incomes. This paper discusses the influence of the application of IRWH on the lives of people in rural villages, especially in terms of the potential to reduce food insecurity and poverty.

*Keywords:* In-field rainwater harvesting, food security, rural communities

## **98. IN-FIELD RAINWATER HARVESTING IN THE THABA NCHU AREA: ASSESSMENT OF LAND SUITABILITY AND THE AGRONOMIC IMPACT**

**Zere, TB, Botha, JJ, Anderson, JJ and Nhlabatsi, NN**

*ARC-Institute for Soil, Climate and Water, P Bag X01, Glen 9360, South Africa  
E-mail: zeret@arc.agric.za*

The In-field Rainwater Harvesting (IRWH) technique has been widely implemented at homesteads of small-scale farmers in the Thaba Nchu area in the Free State Province. A large fraction of the potential agricultural land in this area is currently used as rangeland. Using the IRWH technique, a large fraction of the latter can be used to produce food for humans. This paper presents a description of the natural agricultural resources in the Thaba Nchu area, an assessment of the land area potentially suitable for IRWH, and an assessment of the agronomic impacts of implementing the IRWH technique thus far. Land suitability evaluation was done based on data from previous studies, spatial analysis of available maps, and field observations. Analysis of the agronomic impact was done based on crop yield data from trial plots. Preliminary results indicate that a considerably large fraction of the area currently used as rangeland is suitable for implementing IRWH. Similarly, assessment of the agronomic impact of IRWH indicated that generally the technique resulted in increased crop yields and crop variety, compared to the conventional crop production technique. Although data analysis is still in progress, from the preliminary analysis results it can be concluded that the IRWH technique has considerable positive impact on crop productivity in this area, and that there is great potential for beneficially implementing IRWH on a larger scale.

*Keywords:* In-field rainwater harvesting, crop productivity



## **99. IMPROVING MAIZE YIELDS ON A SEMI-ARID ECOTOPE IN SOUTH AFRICA USING IN-FIELD RAINWATER HARVESTING**

**Botha, JJ<sup>1</sup>, Anderson, JJ<sup>1</sup>, Van Rensburg, LD<sup>2</sup> and Hensley, M<sup>2</sup>**

<sup>1</sup>*ARC-Institute for Soil, Climate and Water, P Bag X01, Glen 9360, South Africa;*

<sup>2</sup>*Department of Soil, Crop and Climate Sciences, University of the Free State, PO Box 339, Bloemfontein 9300, South Africa  
E-mail: bothac@arc.agric.za*

Subsistence farmers occupy a large area east of Bloemfontein in the Free State Province of South Africa. They do not enjoy food security because the area is marginal for crop production. There are three reasons for this: (a) low and erratic rainfall of 543 mm per annum; (b) a high evaporative demand of 2198 mm per annum; (c) dominantly duplex and clay soils on which precipitation use efficiency (PUE) is low due to high runoff (R) and evaporation (Es) losses. It was hypothesized that the in-field rainwater harvesting (IRWH) technique could improve crop yields compared to the conventional tillage (CON) practice normally employed, and thereby serve to improve food security.

To test the hypothesis a field experiment was laid out on the nearby Glen Agricultural Experiment Station on an ecotope similar to that in the target area. Maize was chosen as one of the crops because of its suitability for the prevailing socio-economic and climatic conditions. Four variations of the IRWH technique were compared with CON over the four growing seasons (1999/2000 to 2002/2003). The average grain yields over the four seasons for CON and the mean of the four IRWH treatments were 1 641 and 3 182 kg ha<sup>-1</sup>, respectively, i.e. an overall average improvement of 94 %. For each season the yield from each IRWH treatment was statistically better ( $P = 0.05$ ) than CON. Water balance measurements showed that the reason for the yield improvement by IRWH was due to more water being available for transpiration ( $E_v$ ) by R being reduced to zero and  $E_s$  decreased. Mean values of  $E_v$  (mm), and  $E_v$  expressed as a percentage of  $E_v + E_s$ , for CON and IRWH (means of four treatments) over the four seasons, were 74 mm and 128 mm, respectively, and 29 % and 41 %, respectively. Mean PUE values for CON and IRWH (means of four treatments) over the four seasons were 3.3 and 6.8 kg ha<sup>-1</sup> mm<sup>-1</sup>, respectively.

The experiment also showed that there were significant differences between the four IRWH techniques, the optimum one having mulch in the basins and stones on the runoff strip. It was concluded that the subsistence farmers could improve food security significantly by adopting IRWH.

*Keywords:* In-field rainwater harvesting, maize, semi-arid

## **100. ASSESSMENT OF THE ENVIRONMENTAL IMPACT OF THE IN-FIELD RAINWATER HARVESTING TECHNIQUE**

**Anderson, JJ, Botha, JJ and Nhlabatsi, NN**

*ARC-Institute for Soil, Climate and Water, P Bag X01, Glen 9360, South Africa  
E-mail: andersonk@arc.agric.za*

In an attempt to fight poverty and food insecurity, the in-field rainwater harvesting (IRWH) technique was introduced to small-scale farmers in the Thaba Nchu area of the Free State and five rural villages near Alice in the Eastern Cape over a period of more than ten years. It was hypothesized that the technique is environmentally friendly in terms of the conservation of the natural resources. To test this hypothesis various indicators were used to assess the bio-technical feasibility of the IRWH technique. These indicators included soil water status, soil structure, degree of soil erosion, organic carbon, pH, root density and biodiversity in the topsoil.

Results from field experiments conducted at the Glen Agricultural Experiment Station and the University of Fort Hare have indicated that IRWH with an organic or stone mulch has an 80 % probability of conserving 62 mm and 130 mm more rainwater, respectively, than conventional tillage (CON), due to the suppression of evaporation from the soil surface, total stoppage of ex-field runoff and, hence, also soil erosion. Sediment measurements and estimates have revealed that the basins will take between 12 and 81 years to become filled if no sediment is removed. The period depends on the type of mulch on the runoff area and also in the basins. The carbon content declined by 19 % over a measurement period of five years on the CON treatments and by 10 % for the IRWH treatments. Collection of runoff water in the basins gave the crops a pre-plant water advantage and measurements of soil water content have also indicated that there is more water available for plant growth during the growing season, resulting in higher crop yields. With the IRWH system, community members are able to produce a variety of cash crops and vegetables throughout the year, providing them with a more nutritional diet.

It was concluded that the IRWH technique is effective in the sustainable use and conservation of natural resources, improving soil fertility, decreasing pest, disease and weed pressure and thereby allowing community members to produce a bigger variety of crops with a higher nutritional value.

*Keywords:* In-field rainwater harvesting, environmental impact

# **101. THE CONTROL OF THERMOINHIBITION IN *TAGETES MINUTA*: CELL DIVISION VERSUS CELL ELONGATION**

**Taylor, NJ**

*Department of Plant Production and Soil Sciences, Faculty of Natural and Agricultural Sciences, University of Pretoria, Pretoria 0002, South Africa*  
*E-mail: taylor.nicky@gmail.com*

Germination is one of the single most important factors in agriculture. Uniform germination is of critical importance in terms of harvesting. *Tagetes minuta* L. exhibits erratic germination due to the inhibition of germination at high temperatures, a process referred to as thermoinhibition. The unravelling of this phenomenon will allow a greater understanding of germination and will benefit the essential oil and perfume industries where this crop has great potential. Through numerous germination studies and the use of various inhibitors it was demonstrated that endogenous embryo factors, which act mainly in the radicle, prevent germination in *T. minuta* at high temperatures. These factors act to prevent cell elongation, which is critical for radicle protrusion under optimal conditions. Once the radicle has emerged both cell elongation and cell division are required for post germination growth. Germination at high temperatures can be induced by fusicoccin, which rapidly stimulates cell elongation. In addition, priming seeds at 25 °C on PEG 6000 and mannitol could also induce germination on water at 36 °C, indicating that priming prevents radicle protrusion at a point subsequent to the point of control in thermoinhibited achenes. Flow cytometry studies revealed that DNA synthesis occurs during thermoinhibition and the inhibition of DNA synthesis during this process inhibits subsequent germination on water under optimal conditions, suggesting a protective role for DNA synthesis in thermoinhibited achenes of *T. minuta*.

*Keywords:* cell division, cell elongation, polar auxin transport, priming, thermoinhibition

## **102. EFFECT OF CYTOKININS AND GIBBERELLINS IN TERMINATING POTATO TUBER DORMANCY**

**Rossouw, JA<sup>1</sup> and Hammes, PS<sup>2</sup>**

*<sup>1</sup>PO Box 12, Endicott 1574, South Africa; <sup>2</sup>Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002, South Africa  
E-mail: jarossouw@tuks.co.za*

Potato tubers have a natural dormant period during which sprouting will not occur even under favorable conditions. In South Africa gibberellin is the only product registered to stimulate sprouting. In the seed certification process testing for PVY and PLRV viruses can only commence once dormancy has been terminated. The objective of this study is to determine whether dormancy can be terminated with plant growth regulators (PGRs). The general hypothesis is that a combination of two or more PGRs is much more likely to terminate dormancy than any individual growth regulator.

Fresh tubers were treated with various combinations of gibberellins and cytokinins. Tubers were then cut or left intact. Wounded tubers were placed on moist cotton wool in a dark growth chamber. Sprout development was monitored. A combination of gibberellins and cytokinins terminated dormancy earlier, and increased the number as well as length of sprouts. It can be concluded that a combination of gibberellins and cytokinins terminate dormancy faster than either gibberellins or cytokinins alone. This is in agreement with literature indicating cytokinins and gibberellins react synergistically and may be involved in the reactivation of the cell cycle in dormant meristems. Plasmodesmata may have a secondary effect by blocking the transport of assimilates and PGRs to the cells.

*Keywords:* Gibberellins, Cytokinins, Sprout stimulation

## **103. PRIMING SORGHUM SEEDS WITH PREHEATED AND PRECHILLED WATER FOR EMERGENCE TEST**

**Kaurivi, JZU**

*P Bag 13301, Windhoek, Namibia  
E-mail: jkarivi@unam.na*

A strong seedling results in a good plant development and establishment. Farmers have experienced low germination and seedling establishment in some released varieties of sorghum that resulted from poor seedling emergence (Namibia NARS). We therefore tested three cultivars, *in vitro* at 25°C room temperature, that were identified as either low or high percent seedling emergence: (1) local landrace; and (2) Red sorghum both of high emergence; and (3) Macia, a released variety which has low emergence. Soaking seeds in water at temperatures between 10 to 50°C for 2 to 12 hours had mixed results, but emergence in Macia was continuously lower than the other two cultivars. At 50°C temperatures, the emergence in all cultivars decreased with the duration of soaking, but not when seeds were prechilled at 10°C. Prechilling the seeds had positive effects on the emergence and uniformity of seedlings where Red Sorghum variety attained an average of 90% in all soaking durations, Local landrace 80% and Macia 70%. Priming sorghum seeds with water therefore had mixed responses to temperature and duration of soaking in all three sorghum varieties and it is recommended to prechill the seeds, than to preheat before sowing, for better seedling establishment and uniformity of the crop stand.

*Keywords:* priming, sorghum, temperature

## **104. THE EFFECT OF PHYSIOLOGICAL AGE OF SEED POTATOES ON YIELD OF POTATOES**

**Bosman, D**

*Omnia Fertilizer, PO Box 69888, Bryanston, 2021, Gauteng, South Africa  
Email: dbosman@omnia.co.za*

The effect of the physiological age of seed potatoes on potato yields and the economic impact on the producer, is a cause of concern and was the focus of this Potato South Africa trial work. The importance of the physiological age of the seed potato on yield and quality of the potato crop has been well documented. This study evaluates common on-farm methods to treat seed potatoes.

Seed potatoes were stored in the cold room, in the shed and beneath trees or a combination of these. In Treatment 1, seed potatoes were stored beneath trees for 10 weeks, in Treatment 2 they received three weeks of cold room storage followed by seven weeks beneath the trees, Treatment 3 received five weeks of cold room storage plus five weeks beneath the trees, Treatment 4 had cold storage for eight weeks plus two weeks beneath the trees, Treatment 5 were left in a shed for 10 weeks and Treatment 6 were stored in the cold room for five weeks followed by shed storage for another five weeks.

The combination of five weeks cold storage plus five weeks storage beneath the trees differed significantly from all the treatments except the five weeks cold room storage plus five weeks stored in the shed. With the exception of, the five weeks cold storage plus five weeks storage under the trees, the yield of the other treatments did not differ significantly from one another. After five weeks cold storage plus the storage under trees or in a shed, yields did not differ significantly. This implies that the type of storage after cold storage did not have an influence on potato yield. Little difference in terms of size distribution and classes occurred.

The results of this study emphasize the importance of the physiological age of seed potatoes on potato yield. To maximize profits farmers must take the age of seed potatoes into account.

*Keywords:* Cold storage, potatoes, seed potatoes, yield

## **105. EFFECTS OF SOIL-APPLIED SILICON ON EXTRACTABLE PHOSPHORUS USING RESIN, TRUOG AND AMBIC METHODS**

**Matlou, MC<sup>1</sup> and Haynes, RJ<sup>2</sup>**

<sup>1</sup>*ARC-Institute for Soil, Climate and Water, P Bag X79, Pretoria 0001, South Africa;*

<sup>2</sup>*Discipline of Soil Science, School of Applied Environmental Science, University of KwaZulu-Natal, P Bag X01, Scottsville, Pietermaritzburg 3209, South Africa  
E-mail: mmakgabom@arc.agric.za*

Agricultural activities tend to remove large quantities of nutrients like P from soils. Highly weathered soils containing substantial quantities of amorphous Al and Fe hydrous oxides also adsorb large amounts of P. As a result, concentration of P in the soil tends to decrease. The use of Si fertilizers may solve some of these problems. However, in South Africa, the use of Si as a possible essential nutrient to increase P availability has received sporadic attention. For that reason, a laboratory study was conducted to determine the effects of applied silicic acid, calcium silicate and calcium hydroxide on levels of extractable P in two Si-deficient soils. Two soils (Fernwood and Nomanci) were treated with three rates of P (0, 30 and 60 kg ha<sup>-1</sup>) and three soil amendments (calcium silicate, calcium hydroxide and silicic acid) and incubated for six weeks at room temperature. Application of calcium silicate and calcium hydroxide increased soil pH in both soils while silicic acid additions had no significant effect compared with the control. Concentrations of monomeric and total Al in soil solution generally followed the order: control ≥ silicic acid > calcium silicate > calcium hydroxide. The quantities of P extracted from the two soils by the various extractants followed the order: Truog > AMBIC > resin. The effects of liming (addition of calcium silicate or calcium hydroxide) on extractable P levels differed depending on the soil and extractant used, with an increase, decrease or no effect being recorded. Additions of silicic acid had no effect on levels of extractable P, compared to the control. It was concluded that addition of Si was ineffective at increasing extractable P levels.

*Keywords:* Extractable P, lime, silicon, laboratory incubation

## **106. CHROMIUM AND NICKEL TRANSFORMATION ON MINERAL SURFACES ON HIGHVELD CATENA SOILS**

**Rossouw, PS, Van der Waals, JH, De Jager, PC and Claassens, AS**

*Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002,  
South Africa*

*E-mail: psrossouw@tuks.co.za*

Highveld catena soils, upon which metallurgical slags rich in Cr and Ni are added as a liming agent, were identified and investigated. Nickel occurs in soils as a divalent cation but Chromium can occur in a trivalent cationic species [Cr(III)] as well as a hexavalent anionic species [Cr(VI)]. It is hypothesized that both Cr(III) and Ni will be effectively sequestered by red and yellow-brown apedal soils at neutral pH conditions due to the metals' interaction with sesquioxides. Chromium(III) initially sorbes onto goethite and hematite as a monodentate surface precipitate, but then transforms to a stable multinuclear metal hydrous precipitate. This hydrous chrome precipitate distributes evenly over the iron oxide surface, adopting its mineral structure. The same hydrous oxide has been observed on the surface of silica and the interlayers of smectite clays. The hydrous chrome oxide precipitates as relatively soluble clusters onto silica surfaces, thereby increasing the risk Cr might pose to the environment if added to highly leached soils. Chromium(III) may, especially in concretionary subsoils, be oxidized to Cr(VI) by an array of Mn-oxides. Chromium(VI) may be reduced to Cr(III) by ferrous iron and organic matter, both most probably to be found in pedogenically young E-horizons. Nickel is sorbed onto sesquioxides through inner-sphere complexation. Nickel precipitates as an Al-Ni layered double hydroxide on Al containing minerals, or as Ni(OH)<sub>2</sub> onto minerals not containing Al. Mineral dissolved Si contributes to stabilizing these precipitates by substituting for nitrate and water between the precipitate layers. Although still mobile, the presence of dissolving Si in leached horizons may stabilize Ni precipitates. The effect of an external Si source is being investigated.

*Keywords:* Catena soils



## **107. URANIUM MOBILITY IN SOILS – A SOUTH AFRICAN CASE STUDY**

**Van der Waals, JH, Rossouw, PS, Potgieter, JJH and De Jager, PC**

*Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002,  
South Africa*

*E-mail: johan.vanderwaals@up.ac.za*

Heavy metal guidelines in soils exist for fields such as the agricultural use of sewage sludge but these guidelines cover only a limited number of metals. Uranium receives very little attention in agricultural or environmental soil guidelines. The National Nuclear Regulator (NNR) has guidelines as well as testing procedures for U but these are limited to its radiological risk. Recently, amongst others due to the use of depleted uranium ammunitions (DUAs) during the Gulf War, increased attention is being focussed on the chemical toxicity risk of U in the environment. The South African gold mining industry is a large known source of U in the soils and waters of the Witwatersrand and Goldfields areas. In the absence of adequate U toxicity guidelines large and densely populated parts of Gauteng, the North West and the Free State provinces are exposed to unknown risks. Detail soil investigations are urgently needed to describe the processes involved in U mobility as well as to begin to elucidate the risk that U poses in these environments. An old tailings disposal site was identified and sampled in detail on a grid. Six hundred soil samples were collected and analysed for a range of soil chemical parameters as well as U and other heavy metals. Results indicated that U levels did not correlate well with pH, EC or extractable sulphate levels as was expected. Detail fractionation analysis is being conducted to determine the mobility of the U in the samples.

*Keywords:* Uranium, guideline metal levels, extraction, fractionation

## **108. EFFECTS OF HIGH NI, CR AND MG IN SERPENTINE SOILS ON THE GROWTH OF MAIZE AND RESPONSE TO AMENDMENTS**

**Cooper, GRC**

*Department of Agriculture: Western Cape Plant Production Institute, P Bag X1,  
Elsenburg 7607, South Africa  
E-mail: gavinc@elsenburg.com*

A review of literature attributes serpentine (ultramafic) soil infertility variously to magnesium toxicity, imbalance of Ca and Mg, calcium deficiency, deficiency of macronutrients, deficiency of micronutrients and toxicity of chromium, nickel and cobalt. Significant areas of such soils exist in Zimbabwe and northern South Africa which are not cropped owing to infertility, thus justifying research into the problem. In pot and field experiments a wide range of serpentine soils was investigated using maize as test crop, with and without amendments. Abnormal symptoms were evaluated, responses measured, critical levels in soil and leaf elucidated, mechanisms of toxicity and deficiency identified, and broad recommendations devised. Results of some of these trials are presented.

The main agents of infertility were identified as Ca deficiency, Ni and Cr toxicity and P and other nutrient deficiencies. Specific symptoms were identified for Ni toxicity, Cr toxicity and Ca deficiency; these were respectively interveinal chlorosis, extreme stunting and leaf splitting. All three conditions caused vegetative and grain depression of maize. Calcium deficiency generally accounted for greater yield depression than Ni toxicity. Cr toxicity, although causing extreme yield depression, was rare. Calcium deficiency occurred across the range of soils from red kaolinitic soils to dark vertisols dependent on high magnesium content. Ni toxicity occurred in red coloured soils associated mainly with kaolinite and iron oxides, but also in red vertisols. Chromium toxicity occurred in sub soils subject to seasonal wetness high in manganese oxides.

In managing these soils, soil chemistry and clay mineralogy must be taken into account. Lime was generally better than gypsum in countering Ca deficiency. However, lime and gypsum should be used together where large amounts of Ca were needed to reach critical Ca:Mg ratios of 0.5 on Ni toxic soils. Lime rates must not exceed the level where Zn deficiency is induced, and lime alone should be supplemented with Zn, B and S. Sewage sludge was an alternative to lime on high Ni soils. Extra P was recommended on kaolinitic or vertisolic soils. Zinc was essential on black vertisols and boron was recommended on red kaolinitic Ni-rich soils.

*Keywords:* serpentine soil, calcium deficiency, nickel toxicity, chromium toxicity, amendments, maize

## **109. THE EFFECT OF SOIL-APPLIED SILICA ON THE DEVELOPMENT OF FUSARIUM WILT IN BANANA PLANTS IN GREENHOUSE TRIALS**

**Fourie, W, Van der Waals, JH, Du Toit, ES, Van den Berg, N and Viljoen, A**

*Department of Plant Production and Soil Science, Forestry and Agricultural Biotechnology Institute, University of Pretoria, Pretoria 0002, South Africa*  
*E-mail: wilken.fourie@tuks.co.za*

Fusarium wilt of banana, caused by the pathogen *Fusarium oxysporum* *fc cubense* (*Foc*), is one of the largest problems facing banana production in South Africa. The pathogen enters the vascular tissue of host plants through their roots. Exudates released by the fungus leads to blockage of the vascular tissue subsequently causing typical wilting symptoms in the banana plant. Although certain cultural methods may slow development of the pathogen, no effective methods are known to control the disease. A literature review of the subject indicated positive results through the use of silica as a soil amendment. Positive effects on the growth and disease resistance of plants, due to increased silica levels in the soil, are numerous. The exact mechanism behind this disease resistance inferred by silicon is not yet fully understood although it has been shown to increase mechanical resistance as well as stimulate the production of phenolic compounds in some plants. Investigations into the accumulation of silicon by higher plants showed that banana plants do accumulate silica. Pot trials were established to test the effectiveness of Si treatments against *Foc* in banana. Potassium silicate was used as a soil drench while a silicate slag was utilized as a soil amendment. Soil from a *Foc* infested field in the Kiepersol area was used in the trials. Banana plants will be analysed structurally (light and electron microscopy), physiologically (phenol accumulation) as well as chemically (nutrient levels) to estimate the level of disease resistance that Si may infer on the plants.

*Keywords:* Silica, Fusarium wilt

## **110. ASPECTS OF HYBRIDISATION: A CASE STUDY ON EUCALYPTUS FORESTRY TREES**

**Ramokonyane, TM<sup>1</sup>, Du Toit, ES<sup>2</sup> and Venter, HM<sup>3</sup>**

<sup>1</sup>*Limpopo Department of Agriculture, Waterberg District, PO Box 179, Modimolle 0159;*

<sup>2</sup>*Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002;*

<sup>3</sup>*Tree Improvement, Natural Resources and Environment, PO Box 395, Pretoria 0001, South Africa*

*E-mail: mramokonyane@yahoo.com*

Hybrids are widely cultivated in crop production and forestry worldwide due to their ability to combine desirable traits and their vigour. There are new, recently introduced technologies and are investigated further to establish whether these methods are less labour intensive and less time consuming than the present classical methods. The new technologies include artificially induced protogyny (AIP) and one-stop pollination (OSP) developed by Harbard *et al.* in 1999. The above-mentioned technologies manipulate flower morphology in order to increase seed production for hybrid mass propagation. The main aim of the study is to establish whether the AIP and OSP will improve the seed yield, and to also compare the seed retention of the flowers treated with OSP compared to that of TVP (three visit procedure). The study will also establish if there is correlation between the pollen viability tests *in vitro* and the seed set results from the field.

*Keywords:* Pollen viability, hybridisation, fluorescence technique, artificially induced protogyny, one-stop pollination

## **111. USING IMMATURE LEAF COLOUR TO STREAMLINE THE BREEDING OF BLUSHED PEARS**

**Roberts, SC<sup>1</sup>, Human, JP<sup>2</sup>, Labuschagne, IF<sup>2</sup> and Steyn, WJ<sup>1</sup>**

*<sup>1</sup>Department of Horticultural Science, Stellenbosch University, P Bag X1, Matieland 7602; <sup>2</sup>ARC-Infruited-Nietvoorbij, Stellenbosch, South Africa  
E-mail: sroberts@sun.ac.za*

The ARC-Infruited-Nietvoorbij has a programme in place for the breeding of new blushed pears. However, this is a costly process, as thousands of seedlings are planted out in orchards and maintained for about six years, until they come into bearing. 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. Bearing seedling trees from four crosses were used: 'Doyenne du Comice' x 'Rosemarie', 'Ceres' x 'Bon Rouge', 'Rosemarie' x 'Bon Rouge' and 'Flamingo' x 'Bon Rouge'. Immature leaf colour, mature leaf chlorophyll content, immature fruit colour, and mature fruit colour after storage were measured for the 2005/2006 season. There were some good correlations between mature leaf chlorophyll and fruit colour intensity, and immature leaf hue and fruit hue. Despite some variation between the families, there is a definite trend that seedlings with dark red immature leaves will produce dark red fruit. However, blushed fruit can be produced by seedlings with blushed or green immature leaves. In future, it may be possible to cull young seedlings with dark red leaves, as they will produce fruit that are too dark in colour.

*Keywords:* pear, breeding, leaf colour, fruit colour

## **112. BREEDING NEW IMPROVED CITRUS ROOTSTOCKS TO IMPROVE THE QUALITY AND YIELD OF CITRUS SCIONS**

**Bijzet, Z**

*ARC-Institute for Tropical and Subtropical Crops, P Bag X11208, Nelspruit 1200, South Africa*

*E-mail: zeldab@arc.agric.za*

The quest for an alternative rootstock to the *Citrus aurantium* which was widely used in 1927 has been the first attempt at rootstock breeding in South Africa as well as the basis of the current conventional breeding techniques used. In spite of various constraints such as sterility, self and cross incompatibility, nucellar embryony and a long juvenile period various cross combinations have been made since 1993 and are currently being measured for their ability to impart good quality and production to a scion. Amongst these cross combinations were Chinotto sour orange which was crossed with five different male parents in 1995. G9(Clementine x Nouvelle) was also crossed with the same five male parents so was C9(Nouvelle x Behdlane). Seed was harvested and cuttings were made from the subsequent seedlings. Two to four of each of the above mentioned clonal rootstocks were grafted with Limmoneira 8A lemon and planted along with the original non-grafted seedlings in orchards at Addo in the Sunday River Valley in the Eastern Cape. These crosses were used to determine the influence of the male parents on the ability of the seedlings to impart good quality and production to a scion.

*Keywords:* Citrus, Rootstocks, Breeding

## **113. PLANTLET REGENERATION THROUGH SOMATIC EMBRYOGENESIS OF JACKET PLUM (*PAPPEA CAPENSIS*) TREE SPECIES**

**Mng'omba, SA and Du Toit, E**

*Department of Plant Production and Soil Science, Faculty of Natural and Agricultural Sciences, University of Pretoria, Pretoria 0002, South Africa*  
*E-mail: s23368854@tuks.co.za*

The aim was to investigate embryogenesis in a potential biodiesel crop, jacket plum (*Pappea capensis*) tree species, for clonal multiplication. Leaf and cotyledon explants were explanted on Murashige and Skoog (MS) media with different supplements. Calli were transferred onto MS media with or without growth hormones for somatic embryo regeneration. Thidiazuron (TDZ) alone or with 0.1 mg.l<sup>-1</sup> indole-3-butyric acid (IBA), 0.1 mg.l<sup>-1</sup> benzylaminopurine (BAP) with 0.05 mg.l<sup>-1</sup> α-naphthaleneacetic acid (NAA) and 1.0 mg.l<sup>-1</sup> dichlorophenoacetic acid (2,4-D) with 0.12 g.l<sup>-1</sup> BAP were effective for callus induction. Embryogenic calli were formed under light conditions and when Petri dishes were placed at slanting positions. Cotyledon explants failed to yield embryogenic calli. Three quarter MS media with 0.05 mg.l<sup>-1</sup> TDZ and 0.3 mg.l<sup>-1</sup> CH were effective in somatic embryo germination, but also induced strong rhizogenic capacity. MS media supplemented with 0.2 mg.l<sup>-1</sup> BAP were effective in germination of rhizogenic embryos. Higher TDZ (>1.0 mg.l<sup>-1</sup>) levels resulted in secondary callus production. Somatic embryos were successfully (65%) converted to plantlets and there was more than 60% survival rate after hardened off.

*Keywords:* chlorophyllous, organogenesis, somatic embryogenesis

## **114. EVALUATION AND IDENTIFICATION OF OLD AND NEW MACADAMIA CULTIVARS AND SELECTIONS AT PIETERMARITZBURG**

**Allan, P**

*Horticultural Science, University of KwaZulu-Natal, P Bag X01, Scottsville,  
Pietermaritzburg 3209, South Africa  
E-mail: allan@ukzn.ac.za*

Two main species of macadamia are indigenous to eastern Australia viz. *M. integrifolia* and *M. tetraphylla*. The former was developed commercially in Hawaii from late 1930's onwards, while hybrids between them are also important. Macadamia nuts have been produced successfully in the cool subtropical Pietermaritzburg area by ensuring that pests, especially stinkbugs and borer, are controlled. Newer and older cultivars and selections of macadamias have been evaluated here over periods of from 5 to 35 years. Yields of hybrid cultivars have tended to be higher than those of *M. integrifolia* but, in their sixth year, trees of some of the newer *M. integrifolia* selections have produced good yields of over 10 kg per tree, which is as good as the precocious, hybrid Beaumont (695) cultivar. Older trees have shown alternation of bearing with low averages, over the past three seasons, of 10 to 20 kg per tree on the marginal soils, with close spacing, at Ukulinga research farm. Alternation of bearing and out-of-season flowering are problems that warrant further research including the roles of nutrition and management.

The Hawaiian standards for kernel quality are: *Average kernel mass*: 2.0 or preferably 2.5 to 3.0 g. Larger kernels may not roast evenly to the centre while small kernels are less desirable. *Percent kernel*: over 34% giving good recovery. *Percent No. 1 kernel*: over 95%. These kernels, with high oil content that float on water, will roast to an even light-tan colour. The yield of No. 1 kernels per hectare will determine future profitability as production increases worldwide. While the older cultivars of *M. integrifolia* from Hawaii have produced reasonable quality at PMB, kernel quality is generally better in the newer selections. Selections '783', '842', '887' and 'Daddow' have given best overall quality with hybrids 'A4' and 'A16' giving excellent quality but of very large kernels. Other promising selections, with some quality drawbacks, include '741', '788', '789', '812', '814', '816', '837', '849', '863', 'A38'. Continued evaluation is necessary at PMB, and also in warmer subtropical areas where kernel quality tends to be better. Further research is also necessary on the effect of large kernel size on shelf life of roasted macadamias, especially of those selections that have lower % No. 1 kernel and have to be roasted separately.

Tables of morphological characteristics of typical leaves and fruits of (a) *M. tetraphylla* and hybrids and (b) *M. integrifolia* selections are presented. By working progressively from number of leaf spines on one side of the leaf, through leaf length/width ratio, leaf tip, number of crests, fruit neck, apical point, offset/in line, stalk length and stalk width, one can usually identify a particular selection/cultivar. This makes it possible to differentiate between 34 different selections available in South Africa.

*Keywords: M. integrifolia, M. tetraphylla, morphology, quality, yield*



## **115. PRECISION FARMING (1) – EVALUATION FROM A CHEMICAL AND PHYSICAL PROPERTIES PERSPECTIVE**

**Hattingh, AM<sup>1</sup> and Bloem, AA<sup>2</sup>**

*<sup>1</sup>ARC-Grain Crops Institute, P Bag X1251, Potchefstroom 2520; <sup>2</sup>North West Department of Agriculture, Conservation and Environment, P Bag X804, Potchefstroom 2520, South Africa  
E-mail: hattingha@arc.agric.za*

A precision farming dataset was used to investigate soil chemical and physical tendencies in a 135ha field in the Schweizer Reneke district. Soil chemical and physical information was gathered on a 1ha grid. Yields for 2003, 2005 and 2006 were gathered with a yield monitor. Soil depth varies between 0,8m and 2,4m and yield potential of the field between 2,1 and 6,8 ton ha<sup>-1</sup>. Relative yield (actual yield/predicted yield) shows zones in the field that did not perform as well as expected, but is higher than expected in other zones. In this study, the zones of lower than expected yield is related to high acid saturation, low Ca and Mg contents. However, yield reduction is obtained at much lower levels than 20 or even 15% acid saturation. Ca contents lower than 190 mg kg<sup>-1</sup> and Mg contents of 65 mg kg<sup>-1</sup> are associated with the lower than expected yields. Low K, Ca and Mg are associated with positions where gravel is the underlying material and not always with position of shallow water tables. Positions of water tables are not associated with the deepest soils but rather with positions where clay layers restrict water movement in the subsoil. Prescriptions for fertilizer and lime application should not be made before a full analysis of the data was done.

*Keywords:* Precision farming, chemical properties, physical properties

## **116. PRECISION FARMING (2) – ANALYSED IN THE DEPTH DIMENSION**

**Hattingh, AM<sup>1</sup> and Bloem, AA<sup>2</sup>**

*<sup>1</sup>ARC-Grain Crops Institute, P Bag X1251, Potchefstroom 2520; <sup>2</sup>North West Department of Agriculture, Conservation and Environment, P Bag X804, Potchefstroom 2520, South Africa  
E-mail: hattiingha@arc.agric.za*

A precision farming dataset was analysed on a 1ha grid. Clay contents were determined with the “finger feel method” at 50cm depth intervals. Elevation of the topsoil was measured with the yield monitor on a 135ha field in the Schweizer Reneke district. Elevation of the subsoil is obtained from subtracting soil depth from topsoil elevation. Crosscuts through the field were made to reveal soil depth profiles. From this cross section the clay layers (5, 10, 15, 20% clay etc.) are interpolated and direction of water flow in the profile can be deduced. Topography of the topsoil can only explain part of the variation of the yield, however yield of 2003 (as well as 2005) correlates very good with subsoil topography. Positions with higher than expected yield can be explained from the image of the depth dimension. The reason for accumulation of clay in certain positions in the subsoil can be deduced from the direction of water flow. Processes involved in the forming of the Tukulu, Oakleaf, Pinedine, Westleigh and other soil forms become clear. The reason why the chemical status of the soil is low in a specific area of the field can be deduced from data in the depth dimension. Topsoil Ca, Mg, K contents correlate well with subsoil topography and underlying material. Lateral water movement and accumulation is an important factor in yield determination and should be included in crop water modelling.

*Keywords:* Precision farming, Soil forming processes, Lateral water movement

## **117. CHALLENGES AND SUCCESSES IMPLEMENTING CONSERVATION AGRICULTURE IN DROUGHT-PRONE AREAS OF THULAMELA, LIMPOPO PROVINCE**

**Mulibana, NE, Magagane, R, Barnard, RO and Smith, HJ**

*ARC-Institute for Soil, Climate and Water, P Bag X79, Pretoria 0001, South Africa  
E-mail: elvis@arc.agric.za*

Soil loss through erosion, nutrient depletion and low organic matter are major soil productivity-limiting factors in the Thulamela area of the Limpopo Province. Furthermore, the annual rainfall ranges between 500-600 mm, leaving the area prone to periodic droughts. Apart from problems associated with natural resources in the area, there are others caused by with human (e.g. skills, knowledge and health), physical (e.g. infrastructure), financial (e.g. money) and social (e.g. groups and networks) deficiencies. A project was initiated in 2003 with the aim of introducing sustainable farming systems to alleviate the constraints to crop and vegetable production. The project introduced conservation agriculture (CA) principles to farmers in the area through a participatory approach using the following methodologies: a participatory planning workshop, farmer-led trials and participatory forum meetings. Most of the farmers practise mono-cropping with maize as the main crop. The CA principles offered to farmers allow them to have a wider range of alternatives than the conventional methods currently practised. Some of the main challenges to the introduction and implementation of CA practices are the high initial costs of specialized planting equipment and the high management skills involving a learning process required from farmers. Apart from the above-mentioned there are challenges facing an individual farmer in the Thulamela area, such as small farm size (usually 1-3 ha), land tenure, lack of access to markets, inputs and credit facilities, a lack of knowledge and skills and limited access to information. Although the results have not yet been economically evaluated, it is predicted that CA will increase the profit of the farmers and at the same time address much needed food security. Although there seem to be clear advantages in using CA in this area, the major challenges that need to be addressed at this stage are: capacity building among the stakeholders, institutionalisation of practices and approaches at various levels, provision of appropriate equipment and introduction of a range of alternative crops, including cover crops, in the cropping system. The development of a mulch layer on the soil surface, that would greatly improve soil and water conservation, is probably seen as the most critical and difficult challenge to address. A multi-stakeholder (learning) process should be used to empower stakeholders at various levels with CA principles and practices.

*Keywords:* conservation agriculture

## **118. FARMER RESPONSE TO LANDCARE PRACTICES IN THE QUNU DISTRICT, EASTERN CAPE PROVINCE**

**Smalberger, SA<sup>1</sup>, Steinke, MF<sup>2</sup> and Beukes, DJ<sup>1</sup>**

<sup>1</sup>*ARC-Institute for Soil, Climate and Water, P Bag X79, Pretoria 0001, South Africa;*

<sup>2</sup>*ARC-Institute for Soil, Climate and Water, P Bag X9059, Pietermaritzburg 3200, South Africa*

*E-mail: smalbergers@arc.agric.za*

The Qunu LandCare project was initiated in 2003 with the purpose to develop and diffuse new and appropriate land management practices, making use of conservation agriculture principles, for household food security in the Qunu district of the Eastern Cape Province. The project was designed to address the problems, needs and expectations of the farmers and to contribute to sustainable land use practices in the area. The objectives were: 1) To improve the level of knowledge and skills of farmers; 2) To improve the natural resource management among farmers; and 3) To increase crop yields. Project activities comprised 13 farmer-managed demonstration trials, monthly forum meetings, various training courses and annual farmers' days. The farmer-managed demonstration trials showed an increase in average maize crop yield from a baseline (2003) value of 1.3 t ha<sup>-1</sup> to 2.1 t ha<sup>-1</sup> in 2004 and 3.1 t ha<sup>-1</sup> in 2005.

An Impact Assessment Survey was done to evaluate the influence of the implemented LandCare practices on the Qunu farming community. Twenty-five percent of the farming community was included in the survey. All the surveyed farmers felt that they benefited from the LandCare project. The new practice of conservation agriculture benefited the farmers by yield increase, lower input cost, time saving and better weed control. The farmers' actual yields doubled over the three-year LandCare involvement. They rated all the LandCare activities (Forums/Meetings, Trials/Demos, Training, Farmers' Days and Report-back) as either Excellent or Good. Of the surveyed farmers 30% already applied some of the LandCare conservation agriculture practices on their farms. These are very good results for the relatively short lifespan of the project because, in general, behavioural changes take much longer.

According to the Impact Assessment Survey of the project, the development in farmers' knowledge, skills and attitude in the short term was very successful. There was a definite change towards a positive behavioural and adoptive attitude among the farmers. In the long term we hope that the LandCare technologies will be transferred to other appropriate districts or provinces, which should be made aware of the existence of this demonstration-based technology transfer in the Qunu area. This provides an opportunity for "Look and Learn" visits by which members of other communities can "Learn by Seeing" the efforts of other land users, a most powerful tool for extending the use of new and improved technologies.

*Keywords:* LandCare, Conservation agriculture, Impact assessment

## **119. A COMPARISON OF RUN-OFF ON NO-TILL AND PLOUGHED SOILS FROM MLONDOZI, MPUMALANGA**

Kidson, MV<sup>1</sup>, Jansen van Rensburg, HG<sup>1</sup> and Smith, HJ<sup>1</sup>

<sup>1</sup>*ARC-Institute for Soil, Climate and Water, P Bag X79, Pretoria, 0001, South Africa*  
*Email: michael@arc.agric.za*

Soil erosion is a natural phenomenon that becomes a hazard when human influence causes it to accelerate faster than the natural soil forming process. It is estimated that the annual soil loss for South Africa is 300-400 million tons, or three tons per hectare of land. For each ton of maize, wheat, sugar or other agricultural crops produced, South Africa loses an average of 20 tons of soil.

In trying to combat erosion and other land degradation processes, conservation agriculture is being promoted in many regions of the world. Conservation agriculture has many proven benefits and positive outcomes, which include higher yields, improved infiltration and reduced soil erosion. However, these trends have not been fully quantified, especially in South Africa. Towards this aim, sixteen soil samples taken from no-till and adjoining ploughed fields in Mlondozi, Mpumalanga, were tested under a rainfall simulator. These fields were cultivated for six years and were mainly under mono-crop maize. The no-till soil exhibited improved infiltration rates compared to the ploughed soil. The no-till soil had on average a higher infiltration rate for the first 22 minutes, whereafter it would taper off. The infiltration rate on the ploughed soils, however, declined immediately. The final infiltration rate was the same for both treatments. The results show that there was a reduction in run-off, and hence chance of erosion, under the no-till soil, although the soils never had the desired high-density crop residue cover and multi-cropping systems practised on them. It is postulated that the increased infiltration rates were due to more stable soil aggregates being formed, due to an increase in carbon content and fungal hyphae in the no-till soil compared to the ploughed soil.

*Keywords:* Soil erosion, Conservation agriculture

## **120. BIODIVERSITY PROSPECTING, CONSERVATION AND CULTIVATION OF MEDICINAL PLANTS IN MOGANYAKA, LIMPOPO PROVINCE**

Poto, S.T<sup>1</sup>

<sup>1</sup>*P/Bag X 11208 Nelspruit 1200*

*Email: thabile@arc.agric.za*

Medicinal plants represent a form of biodiversity with a potential to do much better not just in the field of health care, but also in the field of agriculture for rural farmers and traditional healers. The production of medicinal plants offers a possibility of upgrading the lives and well being of people in rural areas. Conservation of these medicinal plants can assist in protecting the environment, habitats, and biodiversity in South Africa. The project focuses on medicinal plants commonly used in South Africa by traditional healers, especially those that have become rare or endangered through over exploitation for medicinal uses or by competition from exotic crops.

A survey in Marble-Hall municipal district revealed that though 83% of the traditional healers agreed to stop harvesting from the wild, 75% of them at the time of the survey still relied on field collection to provide them with material for their profession. Wild ginger and wild garlic were rated amongst the endangered ones as they are no longer available in that area. Planting material was collected from the wild in winter and spring 2005 and planted in a site which has predominately sandy-loam soils. Cuttings, which were collected, were between 0.5 - 1.0m. Before collecting we first surveyed the number of trees per area to indicate how much can be harvested per area. We then collected a maximum of 10 cuttings per area containing a total number of 50- 70 trees. With tubers we collected at least 10 –15 tubers per area. The tubers together with the cuttings were stored in a cooler bag containing dry ice. Plants were labeled indicating the place of collection, type of soil, topography and common climatic conditions of that area. Seeds of moralla and leakalla were collected and soaked in, hot and cold water or directly sowed.

Soaked treated leakalla seeds did not perform well, while seeds directly sowed, germinated 5-6 weeks after planting. Cold water treated moralla seeds germinated well after 4-5 weeks, while seed directly sowed did not deliver good results. Sekanama, sekgakga and mokgotsi, which were planted in August 2005, performed very well, as they adapted to the new environment without being irrigated but relying on annual rain fall as the only source of water. We can recommend the dry land cultivation of medicinal plants to rural, subsistence farmers who do not have access to sufficient water for their gardens.

*Keywords:* Sustainable harvesting, Indigenous Medicinal plants

## **121. THE INFLUENCE OF SEED CLOVE SIZE ON BULB YIELD AND QUALITY OF GARLIC**

Potgieter, JP<sup>1</sup> and Ramodike, MA<sup>1</sup>

<sup>1</sup>*Department of Agriculture: Limpopo Private Bag X 9487 Polokwane 0700  
Email: potgieterjp@agricho.norprov.co.za*

Garlic is reproduced almost exclusively by vegetative means as it does not generally produce viable seed. Due to the high cost of seed cloves, farmers used any size seed clove as planting material. As a consequence, clove characteristics would in all probability influence final bulb yield, quality and profitability. However, scientific information under South African conditions on this aspect of garlic cultivation is scarce. The aim of the research was to evaluate the influence of different seed clove sizes on plant growth, yield, bulb quality and profitability of garlic in Limpopo Province.

Trials were carried out with two garlic varieties at the experimental farm of the University of Limpopo during 2004. Three different seed clove sizes of “Large Egyptian White” (LEW) and “Large Egyptian Pink” (LEP) was planted in a RCBD with four replicates and 18 data plants per treatment. Plant growth characteristics (plant height at harvest), dry bulb yield (bulb mass after curing) and bulb quality (bulb diameter, number of cloves/bulb) were recorded.

Bulb production was strongly dependent on clove size as the highest yields (29.56 t.ha<sup>-1</sup> and 22.93 t.ha<sup>-1</sup>) were obtained with large clove sizes (3-5 g) of both LEG and LEP respectively. Planting larger cloves also resulted in the largest bulb diameter (52.91 mm) for LEW (p<0.05). The largest seed clove size resulted in an increased percentage bulbs graded as large and extra large and ultimately highest gross income. Results of the research showed that the highest yield, quality and gross income was obtained when the largest seed cloves of LEW were used as planting material. This study demonstrated that producers should consider selecting larger seed cloves for higher profit margins.

*Keywords: Allium sativum, seed clove mass, bulb grading, profitability*

## **122. YIELD AND QUALITY RESPONSE OF EGYPTIAN WHITE GARLIC (*ALLIUM SATIVUM* L.) TO NITROGEN NUTRITION**

Mudziwa, N<sup>1</sup>, Motsie, M.L<sup>1</sup>, Soundy, P<sup>2</sup>, Van den Heever, E<sup>1</sup> and Du Toit, E.S<sup>2</sup>

<sup>1</sup>Agricultural Research Council (ARC)-Vegetable and Ornamental Plant Institute (VOPI), Private Bag X293, Pretoria, 0001, South Africa; <sup>2</sup>Faculty of Natural and Agricultural Sciences, Department of Plant Production, University of Pretoria, Pretoria, 0002, South Africa

Email: NMudziwa@arc.agric.za

*Allium sativum* (Egyptian white garlic) is an important crop grown for its medicinal properties. It has also served as a food crop for thousands of years throughout the world. Farmers are unable to produce high yields and good quality bulbs due to under or over fertilizing which results in plants suffering from soil nutrient deficiency or toxicity, respectively. Excessive nitrogen applied late (ten weeks after emergence), can limit yields and increase storage losses in *Allium* crops, while inadequate nitrogen application can hasten maturity and reduce yield. The objective of this study was to determine the ideal nitrogen levels from two sources, namely, ammonium sulfate and calcium nitrate, for optimal plant growth, marketable yield and bulb quality of *A. sativum*. The second objective was to determine the effects of sulfur on yield and bioactivity of *A. sativum*. A field trial was established at ARC-VOPI in April 2006. A randomized complete block design was used with two nitrogen sources (ammonium sulfate and calcium nitrate) at four levels of application (50, 100, 150, 200 kg.ha<sup>-1</sup>). A treatment with no application of fertilizer was used as the control. There was a total of nine treatments with four replicates each. Six plants were harvested monthly to measure crop growth rate as well as nitrogen and sulfur levels in the leaves and bulbs. Preliminary results indicated the highest leaf area index of 318 cm<sup>2</sup> and 346 cm<sup>2</sup> at 200 kg/ha calcium nitrate and 150 kg/ha ammonium sulfate, respectively. The highest fresh leaf mass was 37g at 200 kg/ha<sup>-1</sup> ammonium sulfate and 36 g at 150 kg/ha<sup>-1</sup> calcium nitrate. A final harvest will be conducted to verify these results.

**Keywords:** *Allium sativum*, nitrogen, ammonium sulfate, calcium nitrate



## 123. IMPACT OF NITROGEN FERTILIZATION ON THE GROWTH AND ANTIFUNGAL ACTIVITY OF *TULBAGHIA VIOLACEA*

Van den Heever, E<sup>1</sup>, Allemann, J<sup>2</sup> and Pretorius, JC<sup>2</sup>

<sup>1</sup>Agricultural Research Council (ARC) - Vegetable and Ornamental Plant Institute (VOPI), P/bag X 293, Pretoria, 0001, South Africa; <sup>2</sup>Department of Soil, Crop and Climate Sciences, Faculty of Natural and Agricultural Sciences, University of the Free State, Bloemfontein, South Africa  
Email: Evdheever@arc.agric.za

*Tulbaghia violacea*, an indigenous South African plant, is one of 21 species of the genus belonging to the family *Alliaceae*. It is widely used in the traditional medicinal industry of South Africa. A crude extract from *T. violacea* aerial parts proved to be highly fungitoxic against a variety of plant pathogenic fungi. When cultivated as a donor plant, for the production of a natural product, it is essential that the fertilizer program enhances yield, but not at the cost of antifungal bioactivity. Thus, a trial was conducted in a temperature-controlled glasshouse at a 30/20°C day:night temperature regime to monitor the effect of N-fertilization on growth and bioactivity under natural light conditions. *T. violacea* bulbs were divided into three weight classes (5-10g, 11-20g and 21g) and one bulb from each group planted in a 30 L plastic pot filled with rinsed silica sand (particle diameter of 2 mm). A randomized complete block design was used and each treatment replicated four times. Two nitrogen sources, nitrate and ammonium, were used in order to determine which would yield optimum results in terms of both growth and antifungal activity. Nitrogen was applied at four different rates, i.e. 30, 60, 120 and 180 kg ha<sup>-1</sup>, as a single application at the beginning of the trial. The main objective was to establish both optimum the nitrogen source and application rate that would give high yields and high levels antifungal activity. The seasonal growth pattern of the plant and bioactivity of a crude extract was monitored monthly over a 12-month trial period. It was concluded that nitrate was the preferred nitrogen source at an optimum application rate of 60 kg ha<sup>-1</sup> in terms of both yield and antifungal bioactivity. This was particularly true for plants harvested during October. It is suggested that trials be conducted under field conditions in order to verify these findings.

**Keywords:** *Tulbaghia violacea*, nitrogen, antifungal, bio activity, ammonium, nitrate

## **124. EFFECT OF NITROGEN, PHOSPHORUS AND POTASSIUM NUTRITION ON SEASONAL TOTAL ANTIOXIDANT ACTIVITIES (TAA) OF CULTIVATED BUSH TEA (*ATHRIXIA PHYLCIODES L.*)LEAVES.**

Mogotlane, I.D<sup>1</sup>, Mudau, F.N<sup>2</sup>, Mashela, P.W<sup>2</sup> and Soundy, P<sup>3</sup>

<sup>1</sup>*Agricultural Research Council, Institute for Tropical and Subtropical Crops, Private Bag X 11208, Nelspruit, 1200;* <sup>2</sup>*Department of Plant Production, University of Limpopo, Private Bag X1106, Sovenga, 0727, South Africa;* <sup>3</sup>*Department of Plant Production and Soil Science, University of Pretoria, Pretoria, 0002, South Africa*  
*Email: mogotlane@arc.agric.za*

Antioxidant activity is widely used a parameter to characterize different plant materials for health benefits. This activity is related with compounds capable of protecting a biological system against the harmful effect of reactions that can cause excessive oxidation, involving reaction of oxygen and nitrogen species (RONS). Therefore, the objective of this study was to determine the seasonal effect of nitrogen (N), phosphorus (P) and potassium (K) nutrition on total antioxidant activities (TAA) content in bush tea leaves. Treatments consisted of 0, 100, 200, 300, 400 or 500 kg/ha N, P or K replicated four times in a randomized complete block design under 50% shade nets. Three (N, P and K) parallel trials were conducted per season (autumn, winter, spring and summer). The freeze-dried leaves were ground and analysed for their radical scavenging activity using the DPPH method. The results of this study demonstrated that regardless of season, the application of nitrogenous, phosphorus and potassium fertilizers increased quadratically TAA in bush tea leaves with most of the increase occurring between 0 and 300 N, 300 P and 100 K kg/ha. There were no significant interactions between treatments applied and seasons. Therefore, for improved TAA content in bush tea leaves, 300 N, 300 P and 100 K kg/ha N is recommended.

*Keywords:* Bush tea, total anti-oxidant activities, fertilization, seasons

## 125. MANIPULATING THE FLOWERING OF *NERINE SARNIENSIS*

Warrington, IJ<sup>1</sup>, Brooking, IR<sup>2</sup> and Fulton, TA<sup>3</sup>

<sup>1</sup>Deputy Vice Chancellor and Professor of Horticultural Science, Massey University, Private Bag 11 222, Palmerston North, New Zealand; <sup>2</sup>The New Zealand Institute for Crop and Food Research, Private Bag 11 600, Palmerston North, New Zealand; <sup>3</sup>The Horticulture and Food Research Institute of New Zealand, Private Bag 11 030, Palmerston North, New Zealand  
Email: I.Warrington@massey.ac.nz

*Nerine sarniensis* is a species indigenous to the Table Mountain region of South Africa. It is very popular as a garden species in many temperate areas of the world and is grown as a cut flower crop in several countries including New Zealand where it is exported mainly to Japan. The species is summer dormant, flowers in the autumn and has its main vegetative growth phase from April to September. The normal flowering season is very short lasting only 3-4 weeks, which limits the period for export sales. This research was undertaken to identify ways in which to normal flowering period could be extended without compromising cut flower quality. Bulbs were lifted in either October or December and either replanted immediately or stored at 3°C or 30°C for 4 or 8 weeks. Time to flower bud appearance, first floret opening, proportion of bulbs flowering, and flower quality (floret number, stem length and stem diameter) were measured for three cultivars ('Salmon Supreme', 'Virgo' and 'Magenta Princess').

Bulbs that were lifted in October and stored at 30°C for either 4 or 8 weeks flowered 27-29 days earlier than bulbs from the control treatment whereas those stored at 3°C flowered 11 and 23 days later, respectively. In contrast, bulbs lifted in December and stored at 30°C flowered at a similar time to the control bulbs whereas those stored at 3°C were delayed by 19 and 41 days after storage for 4 or 8 weeks, respectively. The proportion of bulbs that flowered was not markedly altered by storage temperature or time except that it was reduced where bulbs were stored at 3°C for 8 weeks at the December lifting time. Flower quality was not markedly impacted by the treatment conditions used. The time from flower bud appearance to first floret opening was influenced by the prevailing temperature conditions over this growth period. The results of this research have been used successfully in commercial production to effectively extend the export sales period for this crop and to increase the returns received.

**Keywords:** flowering time, flower quality, temperature, storage duration

## **126. HARVEST AND POST-HARVEST TREATMENTS AFFECT VASE-LIFE OF GERBERA CUT FLOWERS**

**Hannweg, K**

*ARC-Institute for Tropical and Subtropical Crops, P Bag X11208, Nelspruit 1200, South Africa*

*E-mail: karin@arc.agric.za*

The cut-flower industry is extremely competitive and needs good understanding of the trade, skill, knowledge as well as experience in growing of flowers in order for any grower to survive. Product quality is everything in this industry and attention to detail is absolutely necessary. Post harvest-handling methods that were developed over 20 years ago for cut flowers are still current practice in the fresh flower industry. Current problems with cut flower longevity and quality are associated with differences in the geographical locations of production, new improved varieties, long-distance transport from farm to market, improper transport and storage temperatures and undesirable handling practices. Experiments were conducted to determine the following: (1) optimum maturity at harvesting, (2) optimum hanging time in the greenhouse, (3) optimum post harvest solution hydration time, (4) optimum solution temperature and (5) optimum pH of post harvest solution. Implementation of recommendations arising out of the above experiments will ensure that growers are able to produce Gerbera cut flowers having a vase-life of at least 14 days. Results of the experiments resulting in recommendations for growers with limited resources will be presented.

*Keywords:* Gerbera, optimum vase-life, harvest and post harvest conditions

## **127. SHOOT THICKNESS – A USEFUL PREDICTOR OF THE RESPONSIVENESS OF SHOOTS OF *PROTEA* CV. CARNIVAL TO AUTUMN-APPLIED BENZYLADENINE INDUCTION OF FLOWERING**

**Hoffman, EW and Jacobs, G**

*Department of Horticultural Science, Stellenbosch University, P Bag X1, Matieland  
7602, South Africa  
E-mail: ewh@sun.ac.za*

Advancement of the flowering time of *Protea* cv. Carnival was achieved by approximately three months through the application of 6-benzyladenine (BA)-containing plant growth regulators to three-flush shoots in autumn. This earlier flowering time coincided favourably with the prime European marketing period (November-January). BA as a management tool to control flowering times in *Protea* is shown to hold commercial potential. However, shoots varied considerably in their responsiveness to BA treatments. Shoot characteristics such as flush length, leaf area, shoot dry mass and leaf number were all positively correlated with the propensity of shoots to initiate inflorescence under BA induction. Shoot diameter as an easily obtainable, non-destructive, but reliable measure to describe shoot quality and assist the producer in the estimation of the propensity of a shoot to initiate an inflorescence upon BA treatment, was evaluated. Terminal buds on three-flush shoots of *Protea* cv. Carnival with a mean stem diameter of  $6.9 \pm 0.07$  mm as well as two-flush shoots of three subjective thickness classes of thin, medium and thick with mean stem diameters (mm) of  $4.4 \pm 0.05$ ,  $5.4 \pm 0.05$  and  $6.0 \pm 0.07$  respectively, were painted in autumn with 500 or 1000  $\text{mg}\cdot\text{L}^{-1}$  MaxCel<sup>TM</sup> (active ingredients BA 1.9% w/w). Comparable shoots were harvested and a number of indicator shoot characteristics determined. Shoot and leaf dry weight as well as leaf- number and area increased from thin to thick two-flush shoots, but were significantly less than for three-flush shoots. The percentage shoots initiating an inflorescence on two-flush shoots increased from 0 to 29 to 76% for thin, medium and thick shoots respectively, but was significantly less than the 96% flowering achieved for three-flush shoots. Shoot thickness was positively correlated with leaf area, shoot- and leaf dry mass and percentage flowering following BA treatment and appears to be a functional non-destructive parameter for selecting shoots likely to flower with BA treatment in autumn. Analysis of an expanded data set revealed that shoot diameter is by far the most determining factor of the inductive potential of shoots treated in autumn with BA, compared to plant age, month of treatment in autumn, or number of flushes that constitute a shoot.

*Keywords:* inflorescence initiation, cytokinin-induced budbreak, Proteaceace, 'out of season' flowering

## **128. ENVIRONMENTAL IMPACT ON THE SEED QUALITY OF GUAYULE (*PARTHENIUM ARGENTATUM* GRAY)**

**Bekaardt, CR<sup>1</sup>, Fenwick, JR<sup>2</sup>, Coffelt, TA<sup>3</sup> and Wiesner, LE<sup>4</sup>**

<sup>1</sup>*Agricultural Research Council, P Bag X5026, Stellenbosch 7599, South Africa;*

<sup>2</sup>*Soil & Crop Sciences, Dept. Colorado State University, Fort Collins, CO 80523, USA;*

<sup>3</sup>*US Water Conservation Laboratory, USDA-ARS, Phoenix, AZ 85040, USA;* <sup>4</sup>*National Center for Genetic Resources Preservation, USDA-ARS, Fort Collins, CO 80523, USA*

*E-mail: bekaardtc@arc.agric.za*

The germination potential of guayule seed is considered too poor for direct seeding. Relating seed quality to field conditions could provide information on suitable locations and management to improve seed quality. The study objective was to determine the seed quality of guayule grown under different field conditions in Arizona. Two trials were evaluated: experiment I compared lines AZ-2, AZ-4, AZ-R2, and 11591 at locations Marana, Maricopa, Yuma Mesa, and Yuma Valley, and experiment II compared lines AZ-2, and 11591 under integrated irrigation of 40%, 60%, and 80% field capacity, and fertilization of high and low nitrogen. Seed germination, empty achene production, viability of ungerminated seeds and achene moisture content was determined. In experiment I, a line x location interaction occurred for normal germination, empty achenes, and achene wet weight. Yuma Valley location and line AZ-4 had the highest seed germination at 59%. Empty achenes were higher in Marana for line 11591 at 56%. In Experiment II the line, irrigation, and fertilization factors were significant for normal seed germination. Only the line factor was significant for empty achene production. Line x fertilization and irrigation x fertilization interactions were significant for achene wet weight. Seed germination was higher with line 11591 at 66%, 55% at 60% irrigation, and 56% at high fertilization. Empty achenes were higher with line AZ-2 at 27%. Experiment I had overall seed germination at 44%, and experiment II was at 39%. Empty achene production was at 36% in experiment I, and 31% in experiment II. The quality of guayule seed under both trial conditions was severely decreased by empty achene production. There is not any indication that soil moisture and nutrient applications improve the seed germination potential. The main reason for empty achene production seems due to the genetic variability of guayule seed production, and related to the environmental conditions of high temperature, rainfall and winds during flower bloom at the trial sites.

*Keywords: achene, fertilization, guayule, irrigation, *Parthenium argentatum*, seed quality*

## **129. TEMPERATURE REQUIREMENTS FOR GOOD QUALITY LACHENALIA POT PLANTS**

**Kleynhans, R, Niederwieser, JG and Louw, E**

*ARC-Vegetable and Ornamental Plant Institute, P Bag X293, Pretoria 0001,  
South Africa*

*E-mail: rkleynhans@arc.agric.za*

Temperature is the main factor influencing flower formation and emergence in many flower bulb genera. *Lachenalia* is a winter flowering bulb crop with a warm – cold – warm growth temperature cycle. Flower initiation and development takes place during the storage period of the bulb. The natural flowering time of cultivars is June – August. During this period there is a very low demand for flowering pot plants in Europe (the main export market), because of the summer holidays. The flowering time thus have to be retarded for flowering during October to April when the market demand is higher. Research on the treatment of bulbs with different storage temperatures to ensure good quality pot plants have been done over the last 15 years. It was found that flowering can be retarded by storing bulbs at 9<sup>0</sup>C directly after harvest. Storage at 20-25<sup>0</sup>C for a minimum of 18 weeks (early flowering cultivars) and 20 weeks (late flowering cultivars) are needed for optimal flower initiation and development. Cold pre-plant temperature treatments can be used to shorten the glasshouse period. A treatment of 9<sup>0</sup>C for three weeks significantly reduced the glasshouse period, but also reduced the quality of flowers. Growth temperatures also influenced the quality of pot plants. The prevailing temperatures in the preparation phase as well as the actual growth temperatures will additionally play a role in the quality of the plant. Cool growing temperatures for both phases are required for best quality.

*Keywords: Lachenalia, pot plant, temperature, quality*

### **130. ENVELOPE RELATIONSHIPS BETWEEN EDTA-EXTRACTABLE CU, NI, PB AND ZN AND SELECTED PROPERTIES OF SOUTH AFRICAN TOPSOILS**

**Herselman, JE<sup>1</sup>, Fey, MV<sup>2</sup>, Steyn, CE<sup>3</sup> and Mills, AJ<sup>2</sup>**

<sup>1</sup>Golder Associates, PO Box 6001, Halfway Gardens, Midrand 1685; <sup>2</sup>Department of Soil Science, Faculty of AgriSciences, University of Stellenbosch, P Bag X1, Matieland 7602; <sup>3</sup>ARC-ISCW, P Bag X79, Pretoria 0001, South Africa  
E-mail: eherselman@golder.co.za

Deficiency or toxicity of trace elements is often ascribed to the influence of soil properties such as pH, texture and cation exchange capacity. The Land Type Survey of South Africa has collected thousands of samples from soil profiles representing the main soil forms and providing comprehensive geographic coverage of the country. Both available and total concentrations of trace elements have been included in the laboratory characterisation of these soils. The objectives of this study were to investigate the relationship between soil properties and trace metal availability in South African soils. The properties studied were clay content, pH(H<sub>2</sub>O), CEC and the base status (S value) of soils sampled from surface horizons. The soils were analysed for Cu, Pb, Ni and Zn by ICP-MS after extraction with 0.2 M NH<sub>4</sub>EDTA.

Segmented quantile regression was applied to the dataset (n = 2135) which was first sorted with respect to each of the soil properties and then divided into 20 classes (segments) of equal size. For each segment the 0.975 quantile for the trace metal concentration was plotted against the corresponding 0.50 quantile value for the soil property. The resultant 20-point curve, termed a chemical envelope, represents a boundary enclosing all observations except extreme outliers and reveals information about the limits of expression of the metal concentration for any particular soil property. The chemical envelope cannot predict the *actual* concentration but can be used to predict the *maximum* available concentration of a trace element which can be expected at the value of the soil property in question in a large sample population. There is some resemblance among the metals in the way that their maxima respond to each of the soil properties. The envelope is roughly linear and positive for CEC and clay content, slightly quadratic and positive in the case of S value and bell-shaped in the case of pH. The envelope equations provide a basis for predicting, on the basis of familiar soil properties, the upper limits of trace element availability not only in most South African soils but perhaps in all soils.

*Keywords:* Quantile regression, micronutrients, geochemical mapping



## **131. COMPARISON OF SOIL EXTRACTION METHODS FOR MULTI-TRACE ELEMENT ANALYSIS IN SOUTH AFRICAN SOILS**

**Steyn, CE<sup>1</sup>, Kirsten, WFA<sup>1</sup>, Lazenby, E<sup>1</sup>, Van Zyl, AJ<sup>2</sup>, Jansen van Rensburg, HG<sup>1</sup>, Claassens, AS<sup>3</sup> and Barnard, RO<sup>1</sup>**

<sup>1</sup>*ARC-Institute for Soil, Climate and Water, P Bag X79, Pretoria 0001, South Africa;*

<sup>2</sup>*Golder Associates, PO Box 6001, Halfway Gardens, Midrand 1685, South Africa;*

<sup>3</sup>*Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002, South Africa*

*E-mail: carl@arc.agric.za*

Soil extraction methods for trace element analysis are continually being developed and in different countries different methods are being proposed for multi-trace element analysis. Methods are used to estimate the risk for either toxicities or deficiencies. The different methods indicate different aspects of risk according to the pool of trace elements that are extracted. However, before risks can be evaluated using the methods, the analysis must be of a suitable quality. Aspects that are of importance are detection limits, accuracy, precision and reliability of the methods.

The objective of this study is to evaluate six different methods (EPA method 3052, DTPA, Ammonium Acetate EDTA, Ammonium EDTA, Ammonium Nitrate and Calcium Chloride) for their suitability in determining different aspects of risk for trace elements in South African soils. The selected methods cover the range of trace element availability from total to exchangeable pools. The methods are evaluated for their suitability and quality using both the Inductively Coupled Plasma (ICP) – Mass Spectrometer and the ICP – Optical Spectrometer. Over 200 soils with different properties, trace element levels and pollution status were analyzed.

Data is presented evaluating the methods for their detection limits, accuracy, precision and reliability using the two different instruments and for a range of trace elements. The methods are also compared for the differences in the level of availability predicted. Recommendations are made for the suitability of use of the methods for different soils and different risk assessment needs.

*Keywords:* trace elements, soil extraction methods, ICP-MS, ICP-OES

## **132. ESTABLISHING GUIDELINES FOR QUALITY ASSURANCE AND CONTROL IN THE PREPARATION OF SOIL SAMPLES IN SOUTH AFRICAN LABORATORIES**

**Lazenby, E<sup>1</sup> and De Beer, WHJ<sup>2</sup>**

<sup>1</sup>*ARC-Institute for Soil, Climate and Water, P Bag X79, Pretoria 0001, South Africa;*

<sup>2</sup>*Tshwane University of Technology, P Bag X680, Pretoria 0001, South Africa*  
*E-mail: esme@arc.agric.za*

To produce reliable analytical data in a laboratory, all steps of the analytical chain have to be understood and controlled. This includes sampling, sample preparation and sample storage. Without these, any subsequent quality control actions will probably become a waste of time. Sampling and sample preparation of soil are regarded as the most important steps towards comparability and reproducibility of soil analyses. A good Quality System is essential for standardization and proof of compliance. In today's competitive environment the optimal use of resources and protection of the client basis is very important. The credibility of a service must therefore not be jeopardized. In this study various Quality Systems were evaluated to develop a system for soil preparation in a South African laboratory. Benchmarking was done through a literature review, as well as laboratory assessments and the completion of questionnaires by key personnel in the South African industry. In the questionnaire, issues such as the confidence in the integrity of a soil sample after preparation, neglected areas in the preparation process, as well as the skills, expertise and training level of staff were investigated. Critical elements in the soil preparation process were identified and recommendations will be made on how to establish quality in the soil preparation process. The benchmarking exercise demonstrated that some of the most critical elements are a secure sample identification system, as well as drying, grinding and sieving of the whole sample and correct splitting procedures, where applicable, to ensure homogeneity. Other elements that are important in a Quality System include personnel and customer management, methodology and safety. The final product will be available as a guideline to any soil preparation laboratory in South Africa to establish its own quality assurance and control measures.

*Keywords:* Guidelines, Quality assurance, Quality control, Quality system, Soil sample preparation

### **133. LABORATORY DETERMINATION OF BASIC HYDRAULIC PARAMETERS OF POROUS MEDIA**

**Adhanom, GT<sup>1</sup>, Stirzaker, RJ<sup>2</sup>, Annandale, JG<sup>1</sup>, Lorentz, SA<sup>3</sup> and Steyn, JM<sup>1</sup>**

<sup>1</sup>*Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002, South Africa;* <sup>2</sup>*CSIRO Land and Water, PO Box 1666, Canberra 2061, Australia;*

<sup>3</sup>*School of Bioresources Engineering and Environmental Hydrology, University of KwaZulu-Natal, P Bag X01, Scottsville, Pietermaritzburg 3209, South Africa*  
*E-mail: goitomadhanom@tuks.zo.za*

Unsaturated water movement can be predicted using Richard's equation or the Green-Ampt equation where both models require soil hydraulic parameters. The soil hydraulic parameters are a pre-requisite for many water flow models to simulate soil water retention characteristics curve (SWCC) and hydraulic conductivity profiles. The hydraulic parameters can be estimated using direct and indirect methods. The direct methods include both field and laboratory techniques. Direct methods are time consuming, expensive and difficult to measure. Indirect measurements include pore size distribution and pedo transfer methods and could be described as simple, quick and less expensive but still require treatment of data with caution. An accurate estimation of these parameters could improve simulations related to soil water profile, drainage and evapotranspiration. The objective of this study is therefore, to estimate the hydraulic parameters of porous media using some laboratory methods. In this study a Bruce-Klute diffusivity test with some analytical analysis to estimate the unsaturated hydraulic conductivity,  $K(h)$  and controlled outflow cell test to determine the water retention characteristics,  $q(h)$  were used. These methods were applied to very fine sand (D36), fine sand (D33), medium sand (FS), Diatomaceous Earth (D.E) and Hatfield sandy clay loam soil (0-60 cm). The soil hydraulic parameters  $q_r$ ,  $a$ ,  $n$ ,  $K_s$  and  $q_s$  were estimated while fitting the van Genuchten equation into the measured soil water characteristics data. The soil water limits for the three grades of sands, Diatomaceous Earth (D.E) and Hatfield sandy clay loam at soil water potentials of  $-10$  kPa and  $-33$  kPa were estimated from the predicted soil water characteristic curves. The soil water limit corresponding to  $-10$  kPa for FS, D33, D36, Soil\* and D.E are 0.22, 0.32, 0.355, 0.356 and  $0.828 \text{ m}^3\text{m}^{-3}$  respectively. The soil water limit corresponding to  $-33$  kPa for FS, D33, D36, Soil\* and D.E are 0.105, 0.205, 0.22, 0.30 and  $0.825 \text{ m}^3\text{m}^{-3}$  respectively. The values of hydraulic parameters for the materials tested varies between 0.00042-0.0476  $\text{cm s}^{-1}$  for near-saturated hydraulic conductivity,  $K_s$ , 0.267-0.828  $\text{m}^3\text{m}^{-3}$  for saturated water content,  $q_s$ , 0.06-0.29 for inverse of air entry potential,  $a$  and 1.16-2.0 for pore size distribution index,  $n$ . The residual water content,  $q_r$ , for all the porous media was assumed as zero.

**Keywords:** Soil Hydraulic Parameters, Bruce-Klute Diffusivity test, Controlled Outflow test, Soil Water Characteristics Curve, Unsaturated Hydraulic Conductivity