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Water and Nutrient Relations and Management of Horticultural Crops

Investigating the potential use of mono-potassium phosphate (MKP: 0-52-34) applied through fertigation as a method to improve salinity tolerance of tomato plants

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Tomato is a moderately sensitive crop to salinity. High salinity alters vegetative growth and production leading to economic losses. The study investigated the potential use of mono-potassium phosphate (MKP: 0-52-34) as a method to increase salt tolerance on tomato (Solanum Lycopersicum L. var. Valouro) plants irrigated with saline solutions (NaCl+CaCl2) of EC: 6,8,10 and 12 dS/m and fertigated with different doses of MKP: 0,2,3 and 3.5g/L. Results of PCA analysis showed indicators of plant growth (plant height and leaf number), flowering (number of clusters and flowers), fruit set and production (fruit number, weight of individual fruit, and yield) were negatively affected by increasing salinity while indicators of fruit quality (titrable acidity, total soluble solids, fruit firmness and pH) were improved.

Plant height and yields were reduced by 22%, 31%, 39%, 40% and 76%, 87%, 90%, 95% under the effect of 6, 8, 10, and 12 dS/m respectively, while improvement in TA, TSS, firmness and acidity peaked at EC=12dS/m. Salinity induced shorter growth cycle; earlier flowering, fruiting and fruit maturity dates. The beneficial effect of MKP in mitigating salinity effect was the most obvious at EC=6/MKP=2 and EC=8/MKP=2 inducing best averages of vegetative and productive parameters compared to EC=6/MKP=0 and EC=8/MKP=0. Leaf and stem composition were also affected by MKP application. The highest N and P contents in stem were observed at EC=10/MKP=3,5 (1,79% and 0,25% respectively) and K content was the highest at EC=6/MKP=3,5 (3,07%). N content in leaves was the highest in the control (2,38%), while P and K peaked respectively at EC=8/MKP=2 (0,19%) and EC=6/MKP=3,5 (2,99%).

Results of polynomial model predicted an optimal use of MKP as fertilizer when applied with respective doses 2g/L, 4g/L and 4g/L, while a non-beneficial use of MKP on salt-tolerance was predicted at EC>10 dS/m.

Keywords:

Tomato, salinity, tolerance, fertigation, mono-potassium phosphate

Effects of early feeding and nitrogen concentration on growth and subsequent flowering performance in plug seedlings of Cyclamen persicum

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Cyclamen (Cyclamen persicum Mill.) is one of the most popular potted flowers worldwide, while slow and aberrant growth of plug seedlings are major production problems. This study aimed to determine the effects of early feeding and optimum solution nitrogen (N) concentration during plug stage on growth and subsequent flowering of Cyclamen 'Laser Synchro Scarlet'. Seedlings applied weekly with 100% Johnson's solution at root emergence had higher leaf area and whole plant dry weight, more flowers, and 2 weeks earlier to flowering than those applied when true leaves grew and developed. Seedlings were applied weekly with Johnson's solution containing 0-28 mM N from the first to the third leaf-stage and results showed that those with 0-4 mM N had chlorotic and few leaves, and low whole plant dry weight. SPAD-502 value and whole plant dry weight increased with increasing N concentration from 0 to 20 mM, and plateaued at 24-28 mM N. Seedlings received 24-28 mM N had most leaves and flowers, highest whole plant dry weight, and took shortest time to flowering.

Keywords:

Nutrition, flowers

The physiological and biochemical responses of tomatoes to drought, heat and combined stress

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Drought caused by insufficient rainfall or deficient soil moisture and heat due to global warming or high temperature in summer have become two main constraints to agricultural production. Simultaneous drought and heat stresses are common, which increased the damage in crop growth and productivity than the individual stress. Our aim was to uncover the difference and linkage of the tomatoes' physiological and biochemical responses to individual and combined stress. Two tomato cultivars (CV1, Sufen No.14; CV2, C-5) were treated at control, drought, heat and combined stress for six days. The leaves from two cultivars at the three stresses showed swollen chloroplasts with disorganized stroma lamella and decreased relative water content. The leaf water loss rate from two cultivars at heat was higher than control, but lower at drought and combined stress. The hydrogen peroxide and the superoxide anion radical of the leaves from tomatoes increased at drought and combined stress. For CV1, heat stress increased the activity of superoxide dismutase (SOD), peroxidase (POD), catalase (CAT) and ascorbate peroxidase (APX), while drought and combined stress decreased the activity of POD, CAT and APX. For CV2, drought and combined stress decreased the SOD and POD activity. Overall, the two cultivars showed similar response to individual and combined stress in the aspect of leaf physiology. Heat stress activate antioxidant enzymes of the tomatoes to protect against the detrimental effects of reactive oxygen species, which was not the same case for drought and combined stress. Our study will not only help us understand the response of tomatoes to individual and combined stress, but also lay foundation for breeding tolerant crop and increasing productivity at abiotic stresses.

Keywords:

tomato,drought and heat, physiological response, chloroplast, antioxidant enzyme

Continuous detection of plant water status in high density `September Bright´ nectarines

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Climate changes are leading to shortages of water worldwide, affecting traditional horticultural management strategies. Improved understanding of crop water requirements, coupled with irrigation automation play a key role for water saving in future fruit crop production. However, although automated, irrigation is often neither efficient nor timely in responding to seasonal changes in tree water need. This study aimed to test plant-based sensors for their efficiency in determining nectarine water status in a modern high-density orchard. The experiment was carried out in an orchard located at Tatura, Victoria, Australia, during the 2017/18 season. Measurements were done on 'September Bright' nectarines grafted on Elberta rootstock, and trained to an open Tatura system (2222 tree ha-1). Fruit gauges and leaf turgor pressure probes were mounted on trees that were

subjected to four different irrigation levels: 100, 40, 20 and 0% of ETc at different fruit growth stages. Fruit relative growth rate (RGR) and leaf turgor pressure (Lp) dynamics were studied and compared to midday stem water potential (Ψstem), the reference method for plant water status detection. Relationships between plant water status indexes (RGR, Lp and Ψstem) and vegetative growth (trunk cross-sectional area, lateral strength and pruning weight), fruiting behavior, fruit size, light interception and leaf gas exchange will be presented and discussed with respect to irrigation management.

Keywords:

Fruit growth, irrigation, Prunus persica (L.) Batsch, turgor pressure, vegetative growth, water potential, water, fruit trees

Application of Different Levels of NPK Compound Fertilizer Influence Growth, Productivity and Quality of Phalsa

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Phalsa (Grewia asiatica L.) is a tropical to sub-tropical fruit crop. Due to its nutritional and health promoting benefits is being cultivated at commercial scale in Pakistan. Application of fertilizer has been reported to play important role to increase production as well as fruit quality. At present very little is known about the optimum fertilizer requirement for phalsa fruit. Therefore, present study was carried out to standardize the level of NPK compound fertilizer for better growth, productivity and fruit qulaity. Different levels of NPK (17:17:17) compound fertilizer were provided at two different times; 1st just before new growth and 2nd just after the time of fruit set. Experiment contained 5 different treatments viz; control, 1200, 1800, 2400 and 3000 g NPK compound fertilizer plant-1 with 5 replicates. Data concerning to vegetative characteristics (canes branch-1, length of cane, size of leaf and leaves cane-1), reproductive growth (flowers cluster-1, clusters cane- 1, fruits cluster-1 and yield plant-1), physical (size of fruit and weight of fruit) and biochemical (soluble solids contents, titratable acidity, SSC: TA ratio, ascorbic acid, sugars, total phenolics, carotenoids,

antioxidants and tannins) fruit quality parameters were collected. Results exhibited that canes bush-1, length of cane, number of leaves, titratable acidity and reducing sugars were found maximum in 3000 g N, P and K compound fertilizer treated plants, than control. On the other side, leaf size, flowers cluster-1, clusters cane-1, fruits cluster-1, yield plant-1, size of fruit, weight of fruit, soluble solids contents, SSC: TA ratio, ascorbic acid, non-reducing sugars, total sugars, total phenolics and total antioxidants were found highest in 1800 g N, P and K compound fertilizer per applied plants. However, tanins and total carotenoids were found maximum in control and 1200 g N, P and K compound fertilizer treated phalsa plants. In conclusion, 1800 g N, P and K treatment per plant was highly suitable in increasing the vegetative growth, fruits cane-1 and biochemical attributes of phalsa plants.

Keywords:

Ascorbic acid; Fruit quality; Mineral nutrition; Phalsa; Sugars;

Effect of Combine Application of Seaweed and Moringa Leaf Extracts on Growth, Productivity and Quality of Kinnow Mandarin

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'Kinnow' mandarin having distinct flavour, aroma, nutritive value and agronomic adaptations is the leading fruit crop of Pakistan with respect to area and production. However, 'Kinnow' facing problems of low productivity and poor quality due to improper tree mineral nutrition management and looking for some low cost effective alternatives. Seaweed and moringa leaf extracts (MLE) being biodegradable growth enhancers, highly nutritive and environmental friendly known to ameliorate the growth, quality and productivity of many horticultural as well as agronomic crops. Hence, present study was conducted to examine the efficacy of combined treatment of seaweed extract (SWE) and MLE on growth of tree, productivity, yield and quality attributes of 'Kinnow' mandarin fruit. Combination treatments significantly increased the macro nutrients i.e. nitrogen, phosphorus, potassium and leaf micro contents (iron, zinc, calcium) nutrients; while, manganese (Mn) contents were not affected significantly. Individual spray of 3% MLE have shown increased leaf size. Multiple sprays of combination treatments improved trees growth, leaf age, yield, drop of fruits, no. of fruits plant-1, marketable and unmarketable fruits percentage. T4 (4 mL L-1 SWE+ 3% MLE) applied after fruit set and pre-mature stage significantly reduced fruit drop percentage, increase yield, number of fruits per tree, total sugars, non-reducing sugars, titratable acidity, ascorbic acid ,antioxidants and carotenoids of fruit however, T5 (4 mL L-1 SWE+ 3% MLE) applied at three reproductive stages have shown remarkable increase in fruit size, weight, thickness of peel, weight percentage of juice, soluble solid contents, TSS:TA, reducing sugar percentage and total phenolic compounds. Conclusively, combination treatment T4 (4 mL L-1 SWE+ 3% MLE) after fruit set and pre-mature stage

significantly improved no. of fruits plant-1, leaf nutrients, quality of harvested fruits and total yield of 'Kinnow' mandarin.

Keywords:

Fruit quality; Kinnow; Moringa leaf extracts; Kinnow

Showcasing a fertigation management strategy for increasing water and nitrogen use efficiency in soil-grown vegetable crops in the FERTINNOWA project

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FERTINNOWA is an EU-funded H2020 Thematic Network whose principal objective is to bridge the gap between research and implementation at farm level in the field of fertigation. One of the tasks of this project is to exchange and showcase technologies to improve water and nutrient use efficiency in fertigated crops in different parts of the European Union. In south-eastern Spain, excessive nitrogen (N) and irrigation application to fertigated, soil-grown vegetable crops in greenhouses has caused appreciable nitrate (NO3-) contamination and over-exploitation of underlying aquifers. To reduce these problems, a prescriptive-corrective management strategy for optimizing N management combined with a simple automatic system for the activation of irrigation based on electro-tensiometers has been developed as a practical system for potential adoption by growers. The proposed management system includes the use of a decision support system (DSS) for the calculation of crop N fertilizer requirements (VegSyst-DSS) combined with the use of different monitoring tools (suction cups, sap analysis and leaf chlorophyll measurement) for the on-going adjustment of N which is supplied in all irrigations through fertigation/drip irrigation systems. During the 2017/18 growing season, this approach is being compared to conventional fertigation management based on local experience. Reductions higher than 30 and 40%, respectively, in applied water and N were achieved in the first two months of cropping. N lost through NO3- leaching was reduced by more than 70%. Full results from a pepper and tomato crop will be presented. The management system and results will be showcased to growers during the growing season to achieve maximum dissemination.

Keywords:

DSS, leaf chlorophyll measurement, nitrogen leaching, sap analysis, suction cup, tensiometer

The response of apricot to water deficit in semi-arid environment of Dobrogea

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The aim of the present work was to evaluate the impact of irrigation with water deficit applied to the apricot plants. Irrigation is a major horticultural activity and is the most intensively practiced operation throughout the vegetation season. In arid and semi-arid regions, irrigation application is a mandatory measure for modern fruit growing. In the context of global warming, water saving is a major objective. Therefore, irrigation with water deficit is an alternative. The plant studied was apricot, 'Orizont' cultivar, twelve years old. He is grafted on the 'Constanta 14' rootstock. The planting distance was 4 m between the rows and 5 m between trees per row. Soil management system was represented by clean cultivation both between tree rows and in the row. The split-plot experiment described here is mono-factorial with irrigation strategy having three graduations. The irrigation regime consists of a fully irrigated treatment (T1, non-stressed) according to the irrigation needs (100% of ETc = ETo x Kc, Penman-Monteith method), a deficit irrigation treatment (T2) irrigated with half the amount of water in T1 (50% of ETc), and a control, non-irrigated treatment (T3). These plots comprised three adjacent fruit tree rows, with the central row containing three trees for measurements and observations. Soil water potential was measured with Watermark resistance blocks installed at four depths: 20 cm, 40 cm, 60 cm and 80 cm at a 1.50 m distance from the tree trunk, with two replicates for each tree. The paper describes fruit quality in semi-arid region of the Dobrogea, Romania. The study suggests that a moderate hydric stress can be profitable for enhancing key fruit quality characteristics.

Prunus Armeniaca, climate conditions, irrigation, soil water content, quality fruit, water, fruit trees

Alleviating the adverse effects of salinity stress on tomato crop (Solanum lycopersicum) using Lithovit (nanofertilizer) applied through foliar spraying

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Salinity is a major abiotic stress affecting tomato growth and production through ion imbalances, inhibition of nutrient uptake and alteration of photosynthetic activity and leading to economical losses. This study reports the effect of Lithovit-standard (nano-fertilizer) on vegetative and reproductive growth of salt-stressed tomato plants. Nano-fertilizer was applied through foliar spraying in three different concentrations: N1:0.5g/L, N2:0.75 g/L and N3:1g/L on tomato salt-stressed plants irrigated by saline water with 5 different salinity levels: S1:2dS/m, S2:4dS/m, S3:6dS/m, S4:8dS/m and S5:10dS/m. Control consisted on applying the five salinity levels without Nano-fertilizer application (N0:0g/L). Exogenously applied nano-fertilizer counteracted the salt-induced adverse effects on plants. It improved plant height of salt-stressed plants compared to the control with a maximum effect at N2. Similarly, it increased leaf number and stem diameter in salt-stressed plants despite the application dose. Flowering characteristics were also improved by nano-fertilizer application under all salinity levels; average number of clusters and flowering capacity in N2/S2 (3.5 and 17), N2/S3 (3.1 and 15), N2/S4 (3.4and 15) and N2/S5 (2.9 and 11) were higher than those in N0/S2 (2.2 and 12), N0/S3 (2.5 and12), N0/S4 (2.1 and 10), N0/S5 (2 and 9). The product application induced amelioration in reproductive parameters; fruit set was improved in all treatments especially in N1/S1 (65%) compared to the control N0/S1 (26%). Although it did not enhance fruit diameter and individual weight of fruit (g), however, it increased yields (g/plant) due to the production of a higher number of fruits despite salinity level with best yields obtained at N1 (N1/S1 (90g), N1/S2 (110g), N1/S3 (115g) , N1/S4 (100g) and N1/S5 (55g) and N2 (N2/S1 (100g), N2/S2 (108g), N2/S3 (122g) , N2/S4 (105g) and N2/S5 (50g) compared to control (N0/S1 (65g), N0/S2 (75g), N0/S3 (70g), N0/S4 (25g), N0/S5 (30g). Consequently, salt tolerance of tomato was ameliorated by nano-fertilizer application.

Keywords:

Salinity, nano-fertilizer, Solanum lycopersicum, tolerance, yield.

A typological concept to predict the nitrogen release from organic fertilizers in vegetable production

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Particularly in vegetable production it is very important to secure the nutrient demands of plants at each state of growth. Several field grown vegetables are known to have a short vegetation period coupled with a high nitrogen demand. If the nutrient need is not covered, there is an increased risk of quality loss which results in products which cannot be sold.

A large proportion of plant available nitrogen in most organic fertilizers is present in organic form and has to be converted in inorganic forms by microorganisms. It is already known that the nitrogen release from organic fertilizers depends on several quality indices like the content of lignin, hemicelluloses or the ratio of organic carbon and organic nitrogen (Janssen 1996; Kumar and Goh 2003; Stadler et al. 2006). However, such relationships are usually present in organic materials that are from the same origin, like manures or slurries. That's why a typological approach based on the ratio of organic carbon and organic nitrogen should give a good prediction of nitrogen release from organic fertilizer (Morvan et al. 2006). This should allow a prediction based on quality indices which are present in farming practice.

A big literature research was done to get the nitrogen mineralization properties of more than 30 organic typological fertilizer categories. Afterwards a single kinetic function was used to predict the inorganic nitrogen supply in each category. A stepwise linear model was generated for each category to predict the mineralization rate up to 12 months after fertilizer application, dependent on organic carbon to organic nitrogen ratio.

Keywords:

organic fertiliser, nitrogen mineralisation, vegetable production

Water and plant protection management in horticultural crops

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Water is synonymous with life – from offering basic nourishment to acting as the foundation for commercial agriculture. It's linked with our ability to remain healthy and productive – or put more powerfully: to keep on living. We're surrounded by water, but that proverbial tide is quickly taking a turn for the worse. Scientists have estimated that by 2030 – only slightly more than a decade from now – the gap between expected water withdrawal and existing supply has the potential to reach as high as 40 percent, a harrowing proposition for the world's population.

An astonishing 70 percent of our fresh water supply is used to support agricultural production. That type of discrepancy definitively points to an imbalance, an unsustainable system. These facts demand new solutions, and innovation that can remedy a seemingly insurmountable challenge. In response novel irrigation systems delivering water just in time to the needs of the plant are being adopted by horti growers.

In cooperation with its partner Netafim - a global leader in drip irrigation technology -Bayer developed - DripbyDrip – a DripProtection solution combining drip irrigation with innovative chemical and biological crop protection. The DripbyDrip technology aims at improving water use efficiency, reducing the number of plant protection applications as well as reducing the exposure of farmers to these products by injecting products into the irrigation system via a closed, contamination-avoiding and self-cleaning transfer system. The customized agronomic solutions with the inclusion of the DripbyDrip technology have shown significant improvements in root and plant health, yield and quality, which led to higher ROI in comparison to current farmers cultivation methods. The results of field trials in Mexico will be discussed. The DripbyDrip technology platform offers opportunities for extended cooperation with nutrient, seed and rootstock providers to optimize resource efficiency and sustainable farming practices.

Keywords:

DripbyDrip, DripProtection, customized agronomic solutions

Effect of exogenous application of Glycinebetaine on tomato plants subjected to salt stress

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In last decades, extensive agricultural activities in Lebanese coastal regions pushed farmers to search for new water sources from wells. Excessive pumping has caused sea water intrusion making of irrigation water a saline one which altered physiological development of various crops such as tomato that is highly cultivated there. The experiment was conducted in order to explore the effect of Glycine betaine that is a natural osmoprotectant on tomato salt tolerance. Therefore, the effect of 2 factors: salinity of irrigation water (S1:2dS/m, S2:4dS/m, S3:6dS/m, S4:8dS/m, and S5:10dS/m) and GB application (GB0:0g/L, GB1:4.5g/L, GB2:6 g/L and GB3:7.5g/L) was evaluated on tomato (var.Sila) plants. Control consisted on non-treated plants (GB0/S1, GB0/S2, GB0/S3, GB0/S4 and GB0/S5). Effects were tested on various parameters such as plant height, leaf number, stem diameter, flowering and fruiting characteristics on several consecutive dates of data collection. Results showed that the positive effect of GB application was limited to some salinity levels; plant height at 55 DAT (Days after Transplantation) was enhanced in GB3/S2 by 22% compared to GB0/S2. Leaf number (55 DAT) was enhanced in GB2/S1 by 15% compared to GB0/S1. Stem diameter, number of flowers (31DAT) and number of fruits (52 DAT) were improved by 24%, 25% and 33% at GB2/S4 compared to GB0/S4 respectively. Number of clusters, fruit set, weight of individual fruit, yield and fruit diameter were negatively affected by increasing salinity levels with no evident effect of GB. On the other hand, GB3 delayed fruit ripening. Concerning fruit firmness, it was the highest in GB0/S5, and in GB2/S3 and GB1/S4 it was higher than GB0/S3 and GB0/S4. Root Mass Fraction (RMF) increased at GB2/S1 by 33% compared to GB0/S1. Although GB application had occasionally a positive effect on some indicators, however it did not enhance tomato production under salt stress.

Keywords:

Lebanon, tomato, salinity, Glycinebetaine, tolerance

Enhancement of tomato (Solanum lycopersicum) tolerance to salt stress by foliar application of Aspirin (Acetyl Salicylic Acid)

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Salinity problem in Lebanon has been increasing threatening the growth of various crops like tomato. Various methods were adopted to alleviate the negative impacts of salinity. Therefore, aspirin application was evaluated as a method to counteract adverse salinity effects on tomato plants. Growth and production of tomato plants (Solanum lycopersicum var. Sila) irrigated with saline solutions of five salinity levels (EC=2, 4, 6, 8, and 10 dS/m) subjected to foliar application of Aspirin (Acetyl Salicylic Acid) in 3 different concentrations (A1: 50mg/L, A2: 75mg/L and A3: 100mg/L) were compared to those of control plants grown under same salinity levels, however not treated with Aspirin (A0). Results showed that plant height and fruit set recorded close average values at 4, 6, and 8dS/m and the lowest values at 10 dS/m. On the other hand, leaf number and flowering capacity were only affected by the factor Aspirin application with close average values in A1, A2, and A3 that were higher than control. “Salinity” and “Treatment” factors had a combined effect on average stem diameter which was the lowest at EC=6dS/m and was improved by A1, A2 and A3. Average number of fruits was the lowest at 10 dS/m despite treatment effect and the highest at A3 despite salinity effect. Aspirin did not enhance weight of individual fruit and fruit yield per plant which decreased with increasing salinity. Date of fruit maturity was similar in A1, A2 and A3 compared to A0 while date of fruit ripening was higher in A1, A2 and A3 compared to A0. Fruit firmness was lowered by decreasing aspirin concentrations and increasing salinity. RMF (Root Mass Fraction) was the lowest at 10dS/m and was enhanced mainly at A1. Although aspirin application did not affect fruiting, however it improved plant growth, root development and flowering characteristics under salt-stress.

Keywords:

Lebanon, tomato, salt-stress, Aspirin, growth, production.

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The aim of this study was to evaluate the growth of aerial and root systems of the ornamental Silver Vase Bromeliad (Aechmea fasciata), submitted to nitrogen and phosphorus fertilization. Silver Vase Bromeliad plants were submitted to a combined fertilization of nitrogen (4.0, 14.5 or 24.5 mM N) and phosphorus (0.1, 1.1 and 2.1 mM P) based on modified HA (Hoagland and Arnon, 1950) ionic balanced solution. The variables analyzed were plant's biometric and biomass measures, and macro e micronutrients contents in the leaves. The nutritional analysis showed that N (9.59, 29.47 and 36.91 g kg-1 N) and P (2.18, 2.95 and 4.23 g kg-1) concentrations in leaves increase as the concentrations of N and P raise in HA solutions. The variables plant height, number of leaves, plant diameter, leaves and total fresh mass, also increase as N concentration raise in HA. The raise of P in HA increase P concentration in the leaves, oppositely did not promote the increment of the others variables. The optimal N concentration in the HA solution was 14.5 mM N. The nutrient N showed was more limiting to Silver Vase Bromeliad growth when compared to P.

Keywords:

Plant nutrition, Bromeliaceae, Aechmea fasciata, Silver Vase Bromeliad, fertilization, ornamentals

Fertilization and energy use of industrial tomato in central Greece

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On-farm energy efficiency is becoming increasingly important in the context of rising energy costs and concern greenhouse gas emissions since today's agricultural production relies seriously on the consumption of non-renewable fossil fuels. Energy inputs represent a major part of the cost production growing fast while consumption of fossil energy results in direct negative environmental ef-fects through release of CO2 and other greenhouse gases. The purpose of this study was to estimate the energy use of industrial tomato cultivation focusing on that used for the fertilization, in representative farms of Thessaly plain, central Greece. Industrial tomato is a significant agricultural

crop of Greece, covering an area of about 15.000 ha of highly mechanized farming systems. Fertilization inputs represent a significant proportion of the tomato input costs and energy consumption. Nine typical farms of industrial tomato were selected representing the main soil-climatic conditions of industrial tomato cultivation in Thessaly. Energy used in each farm was estimated using a decision-support tool, designed for farm scale usage. The results showed that energy use in each farm ranged from 25151 MJ/ha to 86004 MJ/ha. Fertilizers contribution to the total energy consumption ranged from 27.2% to 44.5% of it indicating the appreciable possibilities to improve energy use by adopting appropriate fertilizing management practices. In particular, nitrogen fertilizers represented 72% to 93% of the total energy consumption compared to all fertilizers used, suggesting that efficient nitrogen fertilization in industrial tomato cultivations are among the most important factors for reducing farm energy use.

Keywords:

industrial tomato, nitrogen fertilizers, energy use

Increasing nitrogen application increases leaf protein content of Moringa oleifera (Moringaceae) in South Africa

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Nitrogen is fundamental to the growth, productivity and quality of plants and is essential for amino acid, protein and plant biosynthesis (Liu et al., 2010). The objective of this study were to determine leaf yield and the relationships between N and protein in the leaves with different N applications rates. This trial was conducted over a three season period (2014-2016) on 9-year-old M. oleifera trees at the Experimental Farm of the University of Pretoria, South Africa. Trees were grown from PKM1 variety seeds, sourced in India, and then transplanted to the field. The treatments consisted of three nitrogen fertilizer rates (0, 560 and 960 kg·ha-1). Leaves were harvested in autumn (March) of 2014, 2015 and 2016) . The N application were split into two applications, in July and August of each year

Biomass production of M. oleifera leaves was determined by measuring fresh leaf mass, dry leaf mass, leaf area, nitrogen content and protein content. Results from the trial indicted that M. oleifera leaf area, fresh leaf mass and dry leaf mass increased as well as leaf protein and leaf tissue nitrogen

content increased with N application rate. Therefore there is significant correlation between N content and protein content. Leaf fresh mass increased with N application rate (0, 560 and 960 kg·ha-1) from 0.162 kg, 0.212 kg to 0.218 kg per tree, respectively. The dry leaf mass also significantly increased with N applied and also leaf area increased with N rate.

The study was to evaluate the effects of varying levels of N fertilizer application on protein content and leaf yield. M. oleifera leaves has high nutritional quality as it is rich in protein. Because M. leaves are used as a human and animal food, increasing nitrogen application would increase the nutritional quality significantly.

Keywords:

nitrogen, fertilizer, protein, leaves, nutritional quality

Spatially resolved approach for calculating the water deficit in an apple orchard

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Precision agricultural methods were applied in 6 ha apple orchard (Malus x domestica 'Gala') in semi-humid climate aimed at the spatially resolved analysis of water deficit. In the present study, the measurement of apparent soil electrical conductivity (ECa) (n = 568) as well as soil texture, bulk density, root depth and volumetric water content (n = 20) took place before the bud break at soil field capacity. The ECa (mS/m) was measured with a galvanic coupled resistivity system with a Wenner electrode configuration. Variography was applied to describe the spatial variabilty of the ECa values and Kriging was used to derive a map of gridded data. A pressure bomb was used for the measurement of root water potential (MPa) to derive the wilting point during full bloom, fruit cell division stage, and harvest. Data from weather station located in the field, soil water content at field capacity, estimated wilting point (4.2 pF) and measured wilting point (3.79-4.23 pF) were utilized to obtain the actual evapotranspiration (ETa). The ETa values were implemented in the Geisenheimer irrigation model for calculating the daily water deficit with and without considering depletion. For

comparison, water deficit was calculated based on estimated root depth of 25 cm and spatially resolved, measured root depth as well as for ETa obtained by estimated or measured wilting point.

A strong correlation (r =-0.82) between ECa and the root depth was found, pointing to expected deeper root distribution in sandy soil zones. Furthermore, the ECa correlated with the root water potential during full bloom and harvest with r=-0.51 and r=0.47, respectively. Findings point to tree adaptation by means of decreased osmotic root water potential at time of harvest, when drought stress appeared. Water deficit based on estimated and measured values for root depth and wilting point show higher spatial variability, when the measured plant data were implemented.

These results provide information for better understanding of the spatial heterogeneity of perennial trees that potentially can adapt to the spatial variability of the soil, microclimate, and consequently help to achieve a more efficient understanding for irrigation needs in orchards.

Keywords:

Apple, Precision horticulture, Root depth, Spatial, Water deficit

Boron Application Affects Plant Growth, Root Morphology, and Ion Uptake of Watermelon Seedlings Grown under Hydroponic Conditions

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Boron (B) being essential trace element is critical for physiological functioning of higher plants. A hydroponic experiment was conducted with an aim to evaluate the effect of boron (B) on plant physiological parameters and ion uptake, and find out the best dose of B for optimum plant growth and development of watermelon [Citrullus lanatus (Thunb) Matsum. and Nakai, cv. Zaojia 8424] seedlings. Plants were subjected to six levels of B including control (0 µM, 25 µM, 46 µM, 75 µM, 100

µM, and 150 µM, supplied as H3BO3) for 105 days in hydroponic system. The result shows significant effect of B on plant growth and development as indicated by an increase in the root and shoot growth parameters. B application at 75µM apparently enhanced the root and shoot length, root surface area, root volume, root diameter, and fresh and dry weight of root, stem and leaves compared with 0 µM, and 46 µM treatment. Furthermore, it also improved the relative chlorophyll content (SPAD Index) in top and middle leaves of watermelon seedling. The B concentration was increased in upper leaves, middle leaves and lower leaves up to 29% and 337%, 27% and 194 %, 70 % and 248%, while in stem and root of watermelon by up to 6% and 82%, and 44%, and 225% compared with 46µM and 0 µM B application respectively. Taken together, we concluded that boron has a positive impact on plant growth and development and 75µM B concentration proved better for plant growth compared with 0 µM and 46 µM B concentrations. 46 µM B is considered as a standard (as utilized in Hoagland solution), but our present finding proved that at 75 µM B supply the watermelon seedlings perform better compared with 46 µM particularly at initial stage of growth and development.

Keywords:

watermelon, Boron, Root morphology, ion uptake

A moderate regulated deficit irrigation does not negatively affect flowering, fruit-set and return-bloom in a late apple cultivar

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The aim of this study, which was conducted in South-East France, was to investigate the effects of regulated deficit irrigation (RDI) on flowering, fruit-set, and return-bloom in apple. Trees were subjected to two water regimes: Control, i.e., well-watered (WW) corresponding to grower irrigation based on 85% of evapotranspiration (4 pulses/day), and 50% water deficit in July (water-stressed, WS). Within each shoot size class (short (0.5-1 cm), medium (2-11 cm) and long (≥11 cm)), spur leaf number and spur leaf area were not significantly affected by the water regime. The number of bourse shoots with flower or fruit in terminal position was higher in WS than WW in short shoot category. In the long shoot category, WW gave higher values for the bourse-shoot number in comparison to WS. The number of flowers in all shoot types were similar and ranged between 4.84±0.10 (in short shoots) and 5.26±0.09 (in medium shoots) in WS. There was a rising fruit-set trend in long shoots. To conclude, our results showed that the number of nodes of a shoot in 2013, and the number of spur leaves, spur leaf area, fruit-set of the inflorescence in the year 2014, as well as the frequency of bourse-over-bourse between a couple of years 2012-13 and 2013-14 were not

related to the water regime. Overall, a 50% water deficit over one month in summer for a late season cultivar did not decrease shoot growth in the same year likely because shoot growth was already finished by summer months, but interestingly it did not affect inflorescence development, fruit-set and bourse-shoot formation in the following year. Working on a late cultivar, i.e. 'JoyaTM' here, likely buffers the effects of water deficit. Our study supported the idea that RDI needs to be adapted to the conditions and the cultivar.

Keywords:

Malus x domestica, bourse-over-bourse, orchard, return-bloom, sustainability, water deficit

Effect of water stress on some physiological indices in young pear trees

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Stress from high temperature is closely related to water deficit and drought; drought is lack of water, due to high temperatures. This field experiment was designed to assess some physiological indices affected as response of young 'Williams' pear trees to regulated deficit irrigation (RDI) and mulching. The effect of water stress due to RDI were investigated in young Williams pear trees. Four levels of irrigation were applied, 100% of evapotranspiration (ET) as control (1.6 L h-1 of water per drip) and water deficit in 80% of full ET (1.28 L h-1 per drip) 60% of full ET (0.96 L h-1 per drip) and 40% (0.64 L h-1 per drip). ET was estimated using the FAO Penman Monteith approach. For each treatment we used 10 trees, 5 of which were mulched with wood chips at a 20 cm layer. The experiment was conducted in Kosovo and using a nested experimental design. Based on two–way analysis of variance, we found significant changes in three physiological parameters. The levels of irrigation had an effect on stomatal conductance and leaf temperature, while mulching had an effect on stomatal conductance, leaf temperature and chlorophyll. Irrigation and mulching had a combined influence on three parameters, stomatal conductance, leaf temperature and chlorophyll. High temperatures had an effect on stomatal conductance, respectively, higher the temperature, lower is stomatal conductance. The highest temperatures were found under water deficit 40%. Regarding the effect of mulching, significantly higher stomatal conductance and chlorophyll values were found in mulching treatments. The highest values of leaf temperature were found in no-mulch treatments.

Keywords:

pear, water stress, stomatal conductance, leaf temperature, chlorophyll, water, fruit trees

Production period and nutrient solution in lisianthus (Eustoma grandiflorum) `Mariachi Blue´

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Lisianthus is a very important flowering plant in Mexico, according to the variety and growing conditions it has a relatively short growing cycle from, 3 - 4 months. One of the problems is the lack of information in relation to nutrition; and growers usually use excesive concentration of fertilizers. So the objective of this study was to evaluate the dynamics of growth and postharvest quality of Eustoma grandiflorum 'Mariachi Blue' using the Steiner solution. Two trials were conducted in two periods (autumn-winter (A-W) and summer-autumn (S-A) at the National Autonomous University of Chapingo, state of Mexico. A hydroponic system, under greenhouse conditions was established, and the Steiner solution at different concentrations (50, 75, 100 and 125%) was applied during the growing season, The experimental design was completely randomized with 10 repetitions, the analysis of variance and means comparison test of Tukey were done to evaluate the effect of the different treatments. In plant height the best response was obtained with the 75 % concentration with a height of 62.08 and 60.08 with the concentration of 75 % in the two periods (135 A-W and 91 days S-A). In vase life the highest data were observed with the 125 % in A-W (24 days) but for S-A the flower stems with the concentrations of 75 % and 100 % showed 20 ± 1 day; there were fewer open flowers in the A-W than in S-A period (7-13 and 11-21 flowers respectively); in the variables number of leaves, number of shoots, water consumption and weight loss, the best treatment was 75 %. The summer-autumn period favored plant height, days to harvest and number of open flowers., On the other hand the plants grown with a concentration of the Steiner solution of 75 % showed better growth and flower quality in both periods.

Keywords:

growth, postharvest quality, hydroponics, nutrition

Effect of phosphorus dosed and Mycorrhizal Inoculation On Cıtrus Seedling Growth and Nutrient Uptake

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The mycorrhizal symbiosis is one of the fundamentally important aspects of plant ecosystems and their physiology for healthy plant development and soil quality. Since soils of the Mediterranean region are deficient in nutrient especially phosphorus (P) availability, in other to have optimum plant growth usually heavy fertilizer are used. However, citrus is strongly mycorrhizal dependent it is important to use inoculum for better and healthy seedling growth. Mycorrhiza can reduce the level of applied P fertilizers. Also mycorrhiza can help to plant for better nutrient uptake for healthy growth under marginal soil and environmental conditions. In order to use optimum P fertilizer level for mycorrhizal inoculation P fertilizer level works are still requested.

The aim of the work was to determine the role of mycorrhizal inoculation on citrus seedling growth under different P level application.

Sterilized Menzilat series soil was treated with 0, 50, 100,200 and 400 mg P2O5 kg soil. Fertilizer and sterilized soil was putted in 5 kg pots. Experiments were performed for 5 mounts at harvest plant height, shoot diameter were determined. At harvest, shoot dry matter, mycorrhizal colonization and tissue P and Zn contrition was determined.

Mycorrhizae inoculated plant significantly increased plant growth and nutrient uptake. Since citrus seedling are mycorrhizal dependent, under sterile and low fertile condition plant stunned and seedlings were not grown properly. Seedling length, stem diameter and percentages of root inoculation were investigated. Also mycorrhizal dependency was assessed. Seedling were tested with mycorrhizal inoculation shown that which are strongly mycorrhizal dependent. Mycorrhizal inoculum potential of the soil can have an influence on plant root growth which mainly depends on suitable mycorrhizal partners. In several citrus experiments, it has been found that if the mycoorhizal inoculum species is in agreement with plant species, the seedlings are growing well, if not seedlings develop less.

Keywords:

Citrus, phosphorus, mycorrhizal dependency, hotricultural tree plants

Do Horticultural Tree Plant Species are Depending on Mycorrhizal Inoculation Under Marginal Soil Conditions?

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Since 1995 several field experiments were conducted to search effect of selected and indigenous mycorrhizae spores for horticultural plant species production and nutrient uptake in the Mediterranean region. The effect of several mycorrhizal species inoculation on seedling survives and plant growth also has been studied. Mycorrhizal dependency and growth response of several plants were calculated under several P level applications with several selected exotic mycorrhizae species. Mainly seedling quality, seedling survives under field condition, and yield response to mycorrhizae was tested. Also relationship in between plant growth and root colonization has been studied.

Control, G. Mosseae, G. Etunicatum, G. Clarium, G. Caledonium, Indigenous Mycorrhizae, and Cocktail mycorrhizae species used for, Solanaceae, Cucurbitaceae and Alliaceae family. In another experiment with and without P application were used with and without mycorrhizal inoculation. Fruits of the plant were collated several time and plant leaves and root samples were taken for nutrient content and mycorrhizal colonization respectively in the blossoming period. After several years under field experiment, mycorrhizal inoculation effectively infected plant root and increased plant yield. Since in the area soils have phosphorus and zinc deficiency usually plant tissue P and Zn concentration is under critical levels. And with mycorrhizae inoculation P and Zn concentration erased up to critical levels.

So far results revealed that also indigenous mycorrhiza successfully infected plant roots resulting to a better plant growth. The effect of mycorrhizal inoculation on plant growth is changed by the effectiveness of inoculum and time. For horticultural seedling quality and surviving it is very important. In all experiment first seedlings were produced for several reasons.

Under filed conditions for several years with several mycorrhizae specials plant response to mycorrhizae depend on soil ecological conditions, mycorrhizae and plant species. After several years' field experiments, it has been concluded that for horticultural fruits plants are significantly response to mycorrhizal species. In general, horticultural fruits plants such as melon, watermelon, cucumber, pumpkin, green pepper, eggplant, onion, garlic, leek are mycorrhizal dependent plants. Dependency is pronounced more for P nutrition rather than Zn nutrition.

Horticultural tree plants, mycorrhizal dependency, plant nutrition, soil, sterilization and soil quality

Mycorrhizae Inoculated Vegetable Seedling Production and Use for Field Experiments for Ecological Farming

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Under semi-arid soil conditions, since soils are poor in availability of nutrients because of its high clay and lime content and high pH, mycorrhizal inoculation is seem to be a good strategy for sustainable agriculture. Since it is still very difficult to produce large quantity of mycorrhizal inoculum for large area, it is sound to produce mycorrhizal inoculated seedling and then transplanting to the field.

Green pepper, bell pepper, eggplant, tomato, cucumber, honeymeleon, watermelon, marrow seedlings were produced in different growth medium which are made from different composting material with several mycorrhizal species. Seedlings were produced with different techniques. Mycorrhiza inoculated and non-inoculated seedlings were used under field conditions with different inoculation techniques. The experiments revealed that under field conditions, mycorrhiza inoculated seedlings are effectively established and given high response to plant growth and yield. The results showed that, mycorrhizal inoculated plants have high P and Zn content than not inoculated one.

It has been concluded that seedling quality is much more dependent on growth medium and mycorrhizal spore effectiveness. Also it is important to indicate that using mycorrhiza inoculated seedling it is a good strategy for horticultural production.

Keywords:

Horticultural vegetable seedlings, mycorrhizal dependency, plant nutrition, ecological farming, nutrition, vegetables

Comparing water potential techniques under different water stress levels. A case study of Carménère grapevines

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Irrigation scheduling is a critical aspect of wine production, especially in Mediterranean zones. One of the greatest difficulties of irrigation management is associated with poor or null estimations of plant water conditions. In this regard, water potential, measured by a pressure chamber is widely recognized as a practical tool to quantify the plant water status under field conditions. However, diverse results have been presented in the literature depending on the technique used to measure the water potential (predawn (Ψpd), leaf (Ψleaf) or stem (Ψstem)) as well as, the cultivar characteristics. Therefore, the aim of this work is to determine the suitability of most used water potential techniques (Ψpd, Ψstem, and Ψleaf) for discriminating among plant water stress levels in grapevines cv. Carménère. To achieve this goal the vineyard was managed with four progressive regulated deficit irrigation (RDI) treatments during two consecutive growing seasons and the stomatal conductance (gs) was measured by an infrared gas analyzer (LI-6400) weekly. The entire dataset was divided into 3 gs classes (Mild, Moderate, and Severe) according to the levels proposed in the literature for C3 plants. The suitability to discriminate among water levels was analyzed using a standard K-means clustering method evaluated with a confusion matrix approach. Ψleaf presented the highest variability within classes and the lowest Overall Accuracy (OA) in the classification (40%). Ψpd and Ψstem had a better classification performance, in particular, Ψstem technique presented a high Sensitivity value for the class “Severe” (87%), which is an important aspect for an accurate waters stress control under field conditions.

Keywords:

Stomatal conductance, Regulated deficit irrigation (RDI), pressure chamber; irrigation scheduling, K-means clustering method

Boron distribution and redistribution of `Newhall´ navel oranges was affected by inarching different rootstocks

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Boron (B) deficiency seriously affects citrus fruit quality and production, which could be alleviated by approach grafting with another rootstock (named as “inarching”). However, B distribution and redistribution by inarching different B-tolerant rootstock was not reported before. Here, Newhall navel orange (N) grafted on original Trifoliate orange (T; B-inefficient rootstock, N/T) were inarched with Trifoliate orange (t; B-inefficient rootstock, N/Tt) or Carrizo citrange (c; B-efficient rootstock, N/Tc) seedlings. Plants treated with isotope 10B and natural B were used to investigate: which inarched rootstock combination is better adoptive to the B-deficient condition and how different

inarched rootstocks functions in combinations. Inarching another rootstock enhanced the dry weight and B concentration in new leaves than non-inarched plant. In B-efficient rootstock combination, inarched Carrizo citrange had higher ability to absorb B and transport it to the leaves than inarched Trifoliate orange in B-inefficient rootstock combination. Interestingly, 10B distribution experiment showed that in whole plant, N/Tt had more dry weight biomass and higher B concentration than N/Tc in old and new leaves. In inarched combinations, the original rootstock contributes more B distribution to the scion either inarched by Trifoliate orange or Carrizo citrange. In addition, foliar 10B experiment revealed that B could be redistributed to all vegetative organs, and a higher proportion of 10B was observed in the original rootstock than inarched rootstocks. While, the B redistribution to inarched Trifoliate orange and Carrizo citrange had no significant difference. Our study demonstrated the significant difference of B-efficient and -inefficient rootstock combination on B mobility throughout the plant. It also provided some suggestions about choosing a better rootstock for sustainable growth in B-deficient condition.

Keywords:

Boron deficiency, Citrus, Inarching, Distribution, Redistribution, 10B isotope, nutrition, fruit trees

Irrigation of crops with water as a function of salinity: a horticultural-economic decision-making app

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There are few tools enabling consideration of feasibility of irrigation as a function of water quality based on both crop response and economics. Predicting benefits of leaching salts when irrigating with low quality water is challenging due to the complexities of water and salt behavior in soil-crop systems and due to diverse and changing economic realities. We combined a biological-physical model for crop response to salinity with economic calculations of farm-based costs and benefits to build an application that determines profitability of irrigation of crops as a function of water salinity. The coupled model is implemented in a user-friendly menu- and web-based platform (http://app.agri.gov.il/answerapp/).

The model inputs characterize the relevant physical (soil hydraulic properties, weather), biological (crop response to water and salt), management (applied water salinity and quantity), and economic (yield value, yield determined and static expenses, capital return, water pricing, farm unit size, etc.) parameters. The application returns yield and net profit data for scenarios of interest and allows consideration of the environmental repercussions of economic decisions through calculation of leachate carrying excess water and salts out of the root zone. Values of input parameters, whether

regarding environment and crop or economics, are easily changeable in order to allow specific consideration of any case or scenario.

We present case studies that demonstrate the app's potential for evaluating the sensitivity of variables affecting crop profitability decision making for horticultural crops from farm to regional scales. We suggest that the application, in spite of certain limitations due to its basic assumptions – especially that of steady state conditions, represents a powerful first order tool for agricultural water management decision making when parameterized wisely for any particular question of interest.

Keywords:

water quality, irrigation, decision support, economics

Precision irrigation for horticulture: potential and challenges

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Horticultural cropping systems including fruit tree orchards are commonly faced with non-uniformity causing water-induced spatial variability in growth, yields and product quality that should/would justify variable rate irrigation (VRI). These crops are typically drip irrigated, making them unique compared to crops irrigated via center pivot sprinklers for which precision water management is more established. In this talk the uniqueness and possibilities of and obstacles to precision management for drip irrigation of horticultural crops will be addressed.

The presentation will review relevant literature and bring examples from current research projects and developments. The topics covered will include:

Comparison and contrast to “traditional” field crop VRI. High value crops in small fields and the importance of product quality. Drip irrigation is already “smart”, allowing high sensitivity to temporal needs. How much can we additionally benefit from spatial precision?

Technological challenges of VRI drippers/drip systems. Systems of valves and pipes (expensive, rigid) or variable rate drippers?

OK, there will be variable rate drippers…now what? What about fertigation? Can sensing, algorithms and decision making adopt the methods being developed for field crops under central pivot systems? Point source (trees) vs spatially continual data bring analysis challenges.

Wine vineyards as case studies

Keywords:

variable rate drip irrigation, wine grapes, water, fruit trees

Marketable yield quantity and quality of leek and residual soil mineral nitrogen in relation to nitrogen fertilization

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In Flanders threshold values of soil mineral nitrogen (Nmin) in the soil profile (0-90 cm) in autumn are used in legislation to judge fertilization practices and to evaluate the risk of nitrate (NO3-) leaching during winter. The average Nmin measured in leek fields are high compared to other crops. The objective of this study was to investigate if high Nmin values at harvest can be decreased without reducing yield quantity and quality.

We analyzed Flemish leek field experiments with various nitrogen (N) fertilizer rates (2001-2016). We examined marketable yield quantity and quality and residual soil mineral N (RSMN) to rooting depth (0-60 cm) at harvest from July till April the next year.

Considering the applied mineral N + Nmin (0-60 cm) at planting, the marketable yield was on average higher in July till November than in December till April. The maximum marketable yield was obtained at 150-200 kg applied mineral N + Nmin (0-60 cm) ha-1. Generally RSMN values measured in July till December were higher than those in January till April. This can be explained by higher N mineralization rates in the first case and possibly some NO3- leaching in the latter case. There was no significant difference in scores of abrasion hardness nor leaf color or uniformity at 150-200 kg applied mineral N + Nmin (0-60 cm) ha-1 compared to higher N fertilization rates. Taking into account a mean Nmin value (0-60 cm) at planting of 69±45 kg N ha-1 (average ± standard deviation), mineral N fertilizer rates in the order of 75-125 kg N ha-1 are maximum, which allows RSMN values below 50 kg N ha-1.

These results indicate that N fertilization advices of leek can be reduced without risking a decreased marketable yield quantity and quality but minimizing NO3- leaching during winter.

Keywords:

dose response curve; Nitrates Directive; nitrate leaching; harvest period

Concurrent evaluation of agronomic and environmental aspects of nitrogen fertilizer rates in cauliflower production

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Despite major efforts over the past twenty-five years to decrease nitrogen (N) losses, too high nitrate (NO_3^-) concentrations in surface and groundwater from agriculture remain an important environmental concern, especially in field grown vegetable production regions. A stringent limitation of the N fertilizer rates is accepted to be the best N management strategy to minimize NO_3^- leaching losses.

We analyzed Flemish fresh market cauliflower field experiments with various N fertilizer rates (2000-2015). We examined total and marketable yield quantity and quality and residual soil mineral N (RSMN) to rooting depth (0-60 cm) at harvest.

The results show that the total and marketable yield quantity were much lower with less than 100 kg N ha-1 from N fertilization + NO_3^--N in the 0-60 cm layer. Nitrogen fertilizer rates had a larger effect on the score of curd and leaf color, stem erectness and leaf volume than on curd firmness and uniformity. The RSMN showed a high variation i.e. 31±30 kg NO_3^--N ha-1 (average ± standard deviation) for unfertilized plots. The RSMN of plots receiving maximum and more than 200 kg N ha-1 from fertilization was 82±70 and 110±57 kg NO_3^--N ha-1, respectively. Optimum N fertilizer rates for an early crop will be of the order of 150-200 kg N ha-1, while for a late crop this optimum should be reduced by at least 50 kg N ha-1 as a consequence of higher NO_3^--N at planting, possible N mineralization from crop residues from an earlier crop and differences in N mineralization from soil organic matter.

The results indicate that N fertilizer rates of fresh market cauliflower can be further fine-tuned combining both agronomic and environmental aspects of N fertilization.

Keywords:

fresh market cauliflower; nitrate leaching; Nitrates Directive; curd color, leaf color, leaf volume

Estimation of vineyard evapotranspiration using multispectral and thermal sensors placed aboard an unmanned aerial vehicle (UAV)

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A field experiment was carried out to develop a remote sensing energy balance (RSEB) algorithm for estimating vineyard evapotranspiration (ETa) using multispectral and thermal sensors placed aboard an unmanned aerial vehicle (UAV). During January and February 2017, transpiration and evaporation were computed as a residual from the canopy and soil energy balance, respectively. Measurements of micrometeorological variables, surface energy balance components and remote sensing data were obtained from a drip-irrigated vineyard located in the Pencahue Valley, Maule Region, Chile (35º 25' LS; 71º 44' LW; 90 m above sea level). The performance of the RSEB algorithm was evaluated using measurements of vineyard evapotranspiration (ETEC) obtained from an eddy correlation system. Results indicated that RSEB model overestimated ETa by about 12% with a root mean squared error (RMSE) and mean absolute error (MAE) of 0.45 and 0.31 mm d-1, respectively

Keywords:

evapotranspiration; irrigation; remote sensing; energy balance; olive orchard; UAV

The effects of water deficits on fruit surface temperature and sunburn damage in Cripps Pink apple

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Apple production systems in Australia are geared to supply the best quality fruit so that domestic consumption is sustained and export markets can expand. Growers, however, are faced with extreme variability in rainfall that can severely reduce regional irrigation resources. Many apple orchards are adopting deficit irrigation strategies to cope with reduced irrigation allocation. The objective of this study was to investigate effects of water deficits on fruit surface temperature (FST) and sunburn damage. Irrigation treatments were imposed in a commercial ‘Cripps Pink’ apple (Malus domestica) orchard in the Goulburn Valley region of Victoria, Australia. Treatments were 38, 50, 74, 100 and 162% of grower irrigation practice applied from bud burst to leaf fall. Measurements of stem water potential showed that the 38 – 100% trees were water stressed compared to the 162% trees and this resulted in a reduction in yield and fruit size. Sunburn damage was determined at harvest by separating and counting fruit that visually showed oxidative, browning and necrotic damage. There was no treatment difference in the number of fruit with oxidative and browning damage. Sunburn necrosis tended to increase with water deficit. Approximately 4% of the harvested fruit in the 38% treatment had sunburn necrosis. Observations of FST were made in the 38 and 162 % treatments. Fine-wire copper-constantan thermocouples were inserted just under the skin on the top surface of fruit exposed to direct solar radiation. FST was up to 10°C above ambient temperature but there was no difference in FST of trees irrigated at 38 and 162%. Based on these results, there was no evidence

that water deficits increased FST. The increase in sunburn necrosis may have been associated with an increase in the number of fruit exposed to direct solar radiation from less vegetative growth.

Keywords:

irrigation, stem water potential, yield, fruit size, sunburn necrosis, water, fruit trees

Use of hydrogen peroxide in irrigated horticulture and its effect of seedling germination and growth

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The use of H2O2 in irrigated horticulture is found to have positive effect on water use efficiency and crop yields, decreased dripper emitter clogging with reduced biofouling and root intrusion, decreased root diseases but studies on the phytotoxic effects of H2O2 on horticultural species are limited.

Seed germination for 10 species (within 7 families) were evaluated in H2O2 concentrations between 10 and 1000 ppm. The effects of H2O2 concentrations of 0, 10, 50 and 100 ppm were also assessed on the seedling growth of these species grown in a soil-less media (non-circulating hydroponics).

We find limited phytotoxic effects on seed germination and seedling growth for the range of concentrations of H2O2 used (10 to 1000 ppm) on the seeds of the species studied.

Keywords:

phytotoxicity; seed germination, seedling growth;

Evaluation of selected potted ornamental plants performance under capillary wick irrigation system in Kenya

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Ornamental Horticulture is a major industry in the world, comprising a complex group of enterprises which consume a lot of water. With 640m3 water per capita recharge annually, Kenya is classified as a water deficit country. The current irrigation practice in potted ornamental plants production in Kenya involves the use of hosepipes and watering cans, methods which are laborious and inefficient as water and nutrients are lost through drainage and leaching. Capillary Wick Irrigation System, (CWS), a subirrigation system, is an innovative irrigation technique that is simple to install, operate and uses minimal amount of water and fertilizer. This system would be appropriate for potted ornamental plants in Kenya to address the water scarcity challenge. It was therefore necessary to evaluate its performance in order to determine its suitability in greenhouse potted ornamental plants production. This study was carried out from May 2015 to April 2016 at Jomo Kenyatta University of Agriculture and Technology (JKUAT), Kenya, to evaluate performance of selected potted ornamental plants (Spathiphyllum clevelandii, white anthurium; Cordyline terminalis, red dracaena; Chlorophytum comosum, spider plant; Dracaena fragrans, corn plant and Epiprenum aureus, money plant) under CWS compared to Conventional Irrigation System, CIS (overhead hand watering). The experiment was laid out in a split plot design replicated three times. The amount of water applied in the two systems was determined weekly throughout the growing period. Vegetative growth was assessed in terms of leaf expansion and plant height. The growth data was subjected to Analysis of Variance (ANOVA) and means separation done by Turkey at $p \leq 0.05$. Leaves of Chlorophytum comosum, spider plant; Draceana fragrans, corn plant; and Cordyline terminalis, red draceana expanded faster in the CWS than in the CIS, while for Spathiphyllum clevelandii, white anthurium; and Epipremnum aureus, money plant; the leaves expanded faster in the CIS than in the CWS, however, the difference was not significant ($P>0.01$). For example, Spathiphyllum clevelandii, white

anthurium; for example, maximum leaf length reached was 228 cm grown under CIS and 206 cm under CWS. Over the 12 month period, the ornamental plants in the CIS used 216 litres/plant of water compared to 78 litres/plant for the CWS representing 63.71% water saving by CWS. Thus, CWS has great potential for use in the production of potted ornamental plants production under limited water availability when compared with CIS. This could be attributed to reduced runoff which would also contribute to greater nutrient use efficiency and reduction in environmental contamination assorted with leaching. Studies should be done with more ornamental plant species so as to determine their suitability for growing in the CWS.

Keywords:

Irrigation system, water use, sub irrigation, potted ornamental plants, ornamental horticulture, sustainability

Effects of organic and plastic mulching on soil moisture, temperature and leaf macronutrient concentration of pistachio trees (Pistacia vera.L)

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The present research was performed on 20-year-old pistachio trees (Pistachio vera. L cv Akbari) to study changes in soil moisture and temperature and the response of leaf nutrient concentration as a result of mulching. Field studies were conducted in a randomized complete block design with five replications in Feyzabad city, Iran, for two years in 2014 (OFF year) and 2015 (ON year).Treatments included woodchips (WM), barley residue (BM), polyethylene films were covered with two centimeters of soil with width cuts (PF1) and circular cuts (PF2), polyethylene film was pulled on surface soil (PF3) mulches and control (CK). The results showed that soil water content means under PF1, PF2, PF3, WM and BM treatments increased 3.3, 3.6, 15.5, 2.1 and 1.7% compared to CK treatment (9.8%) at 20-30 and 50-60 cm soil layers in both years. Soil temperature in polyethylene-mulched treatments was always higher than other treatments in both soil layers during the two growing seasons. PF3 treatment recorded the highest mean soil temperature of 38.4°C in 2014 and 38.7°C in 2015. Compared with PF3 and CK, other mulches showed smaller fluctuations in soil temperature. Application of mulch significantly affected leaf P concentration in ‘off’ year and N, P and Mg in ‘on’ year. The highest leaf N, P and Mg concentration was recorded in trees of BM

treatment. PF3 decreased leaf N concentration (1.81%) of 'on' year trees below its critical level (2.10%) for pistachio. Generally, our findings showed that polyethylene films sub soil and organic mulches can be an effective management option for improving water storage and nutrient uptake, while it seems polyethylene film on surface soil despite the high water storage due to soil temperature increase over the optimal range had negative impacts on pistachio nutrition in arid and semiarid areas.

Keywords:

Barley residue, Nutrition, Polyethylene film, Water management, Woodchips mulch

Understanding farmers' choices and management practices in fertigated horticulture

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Irrigated horticulture is facing rising competition worldwide for access to reliable, low cost, high-quality water. Farmers are under regulatory pressure to improve fertigation efficiency and reduce emissions. However, there are differences between the concepts of efficient water use as viewed by scientists, regulators, and farmers and often technologies are not adopted by farmers. FERTINNOWA is an EU-funded H2020 Thematic Network whose principal objective is to bridge the gap between research and implementation at the farm level. To achieve that goal, a bottom-up approach was used and face-to-face interviews were carried out with farmers. We compared and analyzed the farmers' practices in terms of water source management, fertilizer application, irrigation management, spotlighting the role of crop indicators to decide and trigger the operations. 371 growers' interviews were carried out in eight European countries and South Africa by the FERTINNOWA consortium on a high diversity of cropping systems covering a wide range of horticultural crops (fruits, vegetables, and ornamental plants).

The management measures applied varied considerably among growers, depending on the production system and farm-specific circumstances. Mainly, growers from the UK, Spain and South Africa were considering using more sustainable water source. The study determined that water use efficiency was not a key driver for adoption of sustainable fertigation practices (drip irrigation and soil moisture monitoring) and adoption was generally not limited by lack of knowledge but by the investment costs. Groups of growers were identified that had no need and/or ability to change unless the external operating environment was to change e.g. regulation, access to water. However, some growers were willing to change their fertigation management, but they required more support or were facing legal restrictions and bottlenecks.

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Keywords:

irrigation, fertigation, water resource, survey, horticulture

Influence of neem leaf fortified fertilizers on tea yield and soil chemical properties

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Economic enhancement, fertilizer scarcity, food security, soil productivity, tea production.

Fertigation in Citrus: A way forward to mitigate the climate change

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Citrus trees are evergreen, grown in tropical and subtropical climates of the world. Kinnow (Citrus reticulata) is one of the most important and unique fruit of citrus group due to its economic and dietary value. The fruits grow best between temperature ranges of 13°C to 37°C. Soil temperature around 25°C seems to be optimum for root growth. Frost is highly injurious. Hot wind during summer

results in desiccation and drop of flowers and developing fruits. Under the drastic changing climate scenario, with the temperature increasing and precipitation fluctuations, water availability and crop production are likely to decrease in the future. Drip irrigation and fertigation are the most efficient methods of modern irrigation systems which has a potential advantage of water and fertilizer saving. Fertigation which combines irrigation with fertilizers is well recognized as the most effective, economical and convenient means of maintaining optimum fertility level and water supply. Fertigation offers the best and sometimes the only way of ensuring that nutrients enter the rootzone in areas with inadequate rainfall and adverse climatic conditions. Under the changing climate scenario an attempt has been made to grow citrus under fertigation condition. The results obtained showed that the citrus crop profusely responded under fertigation condition in terms of growth and yield. The economics of experiment have also shown tangible results from farmer's point of view.

Keywords:

Key words: Kinnow, Fertigation, Growth parameters, Yield, Economics

Thermal imaging to assess water status of almond trees

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Water scarcity is the most limiting factor in irrigated areas of Mediterranean countries. In this regard, in the last few years, different strategies and tools are being implemented in order to improve the water management, together with the introduction of alternative crops characterized by their tolerance to drought situations. Thermography have been progressively introduced as a promising technique for irrigation scheduling and the assessing of crop-water status, especially when deficit irrigation (DI) are being implemented. However, up to day, an important limitation is related to readings interpretation, and the taking decisions for irrigation scheduling, which is in many cases, a severe limitation to its practical usage by farmers and technicians. This work evaluates the potential and robustness of thermal imaging to assess the water status in three almond cultivars; which were subjected to three different irrigation regimes: i) a full-irrigated treatment, which received 100% of crop evapotranspiration (ETc); an over-irrigated treatment; which received 150% ETc; and a regulated-deficit irrigation treatment, which was irrigated at 65% of ETc during the kernel-filling period. There were obtained the non-water stress baselines for each treatment and variety; defining the optimum values of the difference between canopy and air temperature, relating to the values of vapour pressure deficit (VPD). Finally, and considering the final yield values, there were defined the optimum functions to obatin the best yields, maximizing the irrigation water savings. Moreover, thermal information was confronted with other related physiological information (leaf water potential, Ψleaf; and stomatal conductance, gs). The obtained results allow concluding that the best

fucntions in order to improve the irrigation scheduling in almond crop. specially when DI strategies are being applied.

Keywords:

Thermography, Deficit-Irrigation programming, crop Physiology, crop-water stress index.

Effect of Different Soluble Potassium Fertilizers on Yield, Yield Components and Quality Properties of Different Tomato Varieties Irrigated by a Drip System

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Tomato (Solanum lycopersicum) is one of the main crops grown in Turkey. It is grown for table, for paste industry and under protected conditions.

The objective of this study was to examine single and combined effects of some soluble potassium (K) fertilizers as nitrate of potash (NOP), sulphate of potash (SOP) and (NOP+SOP) on yield, yield components, some quality properties of a greenhouse tomato for table and a field cv for paste industry which were irrigated by a drip system.

Results in relation to paste tomato showed that highest EC, titratable acidity (TA), firmness, total soluble solids (brix), fruit width, height and weight (FW, FH, FW) were found in the NOP+SOP treatment. The highest yield was obtained from the SOP treatment and the lowest in the NOP treatment.

Table tomato results put forth that firmness and TA were found high in the NOP+SOP treatment but the highest EC and Brix were in the SOP treatment. Fertilizers applied by fertigation significantly affected the fruit yield, the highest yield being in the NOP+SOP treatment parcels.

It can be concluded that yield is important for both of the cv but brix yield obtained from per unit area in the case of paste tomato and marketable yield with attractive and tasteful fruits in the case of table varieties are significant and needed to be highlighted. In this regard, economic analysis should also be made before deciding on the fertilizer recommendation.

Keywords:

Tomato (Solanum lycopersicum), soluble K fertilizers, NOP (nitrate of potash), SOP (sulphate of potash), yield, yield components

Hydraulic conductance and transpiration rates in droughted olive

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Olive (Olea europaea L.) genotypes have developed various strategies to cope with drought stress. Although some mechanisms of leaf dehydration tolerance are known and genotypes can either show isohydric or anisohydric behaviors, insights on adjustments in stem and root hydraulic conductance (K) after prolonged drought are yet to be explored. This work investigated K regulations and transpiration mechanisms in two olive genotypes showing different responses to drought stress. The experiment was conducted in summer 2017 under greenhouse conditions. One-year-old potted 'Nocellara del Belice' (NB) and 'Cerasuola' (CE) plants were firstly bagged to avoid evaporation from soil surface and then half of them were drought-stressed (DS) for more than 30 days, until almost no weight loss by means of transpiration. Pots were weighed each day to determine transpired water, and control plants (WW) were watered daily by reintegrating the total amount of water lost during the previous 24 hours. At the end of the drought period, above-ground and below-ground portions of plants were collected separately to determine K with a high-pressure flow meter (HPFM). K values where then normalized using the cross-sectional sapwood and sapwood specific conductances (Ks)

were compared. On average, Ksstem values of the two genotypes were found 3-fold higher than Ksroot. However, a significant interaction was found between drought and plant sections (stem/roots), indicating that drought induced an increase in Ksstem but did not affect Ksroot. Despite the overall increase in plant K by 58% after drought, no significant differences were found between the two genotypes. On the other hand, transpiration responses to drought emphasized differences between the two cultivars. NB plants were able to keep a normalized transpiration rate (Tn) stable until a transpirable soil water fraction (Wfraction) level of 0.45, whereas the threshold for CE plant was Wfraction=0.55. Conversely, the decrease in Tn was significantly steeper in NB than in CE, indicating a lower predisposition to cope with sudden drought events in the former. Overall, CE plants appear to be more prone to slowly tolerate quick tissue dehydration than NB, probably due to stomatal regulation rather than modifications of xylem conductance.

Keywords:

Olea europaea L., potted plants, sap, stomatal regulation, water deficit, water, fruit trees

The Effects of Some Plant Growth Promoting Bacterias on Melon Yield and Fruit Quality

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In this study, we investigated the effects of 3 different PGPR and their cocktail on melon plant growth parameters, yield and fruit quality. For this purpose, 3 different PGPR species including, Bacillus subtillis, Enterococcus spp.,Bacillus megatorium and their mixture were used. The plant growth parameters of plant height, stem diameter leaf number, fresh and dry leaf weight, biomass were measured during the field stage of the experiment. At the end, each melons that belong to specific treatment, were harvested and measured by the height. According to the results, all PGPR species increased the certain plant growth parameters. Especially Bacillus subtillis significantly increased all the plant growth parameters and some fruit characteristics that measured. On the other hand, not any species of PGPR effected on yield of melon.

Keywords:

organic farming, PGPR, melon, yield, growth

Water saving irrigation strategies for mango (Mangifera indica L.) cultivation in the Mediterranean subtropical environment

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Agricultural drought has a significant impact on crop yields and, therefore, food security within the context of global climate change. For growing crops successfully in this adverse scenario will be crucial to adjust to less available water. The implementation of efficient water-management strategies will be is a key element to increase agricultural water productivity. This is the case for subtropical Mediterranean farming, particularly terraced mango (Mangifera indica L.) orchards in south-eastern Spain. The subtropical fruit production in this zone is possible with intensive irrigation on terraces, which are economically more profitable than traditional rainfed crops, almond and olive, which have been replaced or abandoned. Our findings have demonstrated that the highest yield and water-use efficiency were attained by reducing the ETC to 50%, and thus the greatest volumes of water did not increase fruit yield. However, the fully irrigated trees (100% ETC) produced the greatest fruit length, width and weight. In addition, the largest size was recorded with full irrigated trees, which invested the extra irrigation water in vegetative growth rather than in fruit yield. Thus, the deficit-irrigation strategies should be adopted as the most appropriate strategy in order to maximize productivity, and promote water-saving programmes in subtropical Mediterranean environment.

Keywords:

Mango, deficit irrigation, agricultural drought, subtropical Mediterranean farming, water, fruit trees

Productive response and irrigation water use efficiency of pepper (Capsicum annuum L.) to different deficit irrigation regimes

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Nowadays, water is an essential resource in the Mediterranean area, particularly for food production, since agriculture consumes more than 60% of the total freshwater of the planet. Therefore, irrigation water use efficiency should be improved, which could be achieved by an adequate irrigation management. For this reason, the productive response and the irrigation water use efficiency in response to three irrigation management strategies (D1, D2 and D3) have been studied, applying 50, 75 and 100% of the crop evapotranspiration (ETc), respectively. The ETc was determined from the reference evapotranspiration, which in turn was calculated from the evaporation pan class A, with a single crop coefficient, adjusting the duration of each phase to the growing cycle. The irrigation depths were 408, 596 and 787 mm in D1, D2 and D3 respectively. The strategies D3 and D2 leaded to the highest marketable yields (7.72 and 5.57 kg m-2, respectively), higher than that obtained in D1 (1.54 kg m-2, p≤0.01). Furthermore, D1 showed a higher appearance of fruits with blossom end rot (4.10 kg m-2, p≤0.01), followed by D2 (1.90 kg m-2) and D3 (0.94 kg m-2). Fruit quality parameters as firmness, colour indexes, vitamine C, polyphenols and acidity were not altered by the analysed irrigation strategies, while, º Brix increased with the decrease of irrigation doses. The lowest irrigation water use efficiency (4.21 kg m-3) was obtained in D1.

Keywords:

Evapotranspiration; irrigation dose; fruit quality parameters; blossom end rot

The Effects of Liquid Vermicompost Applications on Yield and Some Plant Growth Characteristics of Onion

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This study was conducted in order to determine the effects of liquid vermicompost applications on yield, quality and plant growth in onion growing during the 2017 vegetation period in open field conditions in the application areas of İnönü University Faculty of Agriculture Department of Horticulture. Except control plants which were fertilized with conventinal fertilizers, liquid vermicompost applied plants were fertilized only with liquid vermicompost and applications were done in 3 doses (20 lt / da, 40 lt / da and 60 lt / da) divided in two applications. The experiment was carried out in 3 replications according to the randomized plots design. Harvested bulbs were examined in terms of total yield (kg / da), plant height (cm), bulb length and diameter (mm), skin flesh thickness (mm), ax diameter (mm), single fruit weight (g), pH, total soluble solids (%), titrable acidity and L, a, b color values. According to the results, it was determined that liquid vermicompsot applications significantly effect total soluble solids (%), L, a and b color values, pH and total yield (kg / da). The highest average yield (1321 kg / da), average fruit weight (121,86 g / bulb), bulb diameter (67,45 mm) and a color value (15,16) were obtained from plants applied with 40 lt / da liquid vermicompost, while highest total soluble solids (16%) and L color value (49,26) was obtained from plants applied with 60 lt / da. When the results of all parameters evaluated together, it was concluded that in onion fertilization the best dosage of liquid vermicompost application included in this study is 40 lt / da.

Keywords:

vermicompost, liquid form, tomato, plant growth parameters

Use of Aerated Water for Irrigation of Horticultural Crops

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Deficiency of oxygen in the root zone can often be an issue for drip irrigated and hydroponically grown crops. Crop rhizosphere experience hypoxia particularly in heavy and compacted soil structures and exacerbates with high water temperature, salinity, and increased loads of organic materials and biological oxygen demand in the irrigation water.

Use of aerated water for irrigation could offset the hypoxia in crop root zone. Different methods have been utilized for aerated of irrigation water for research. These presentations provide overview and summary oxygation research conducted in CQU over the 15 years.

We present the results for the use of various air injectors, Seaair diffusion systems, use of fluidic oscillator, use of oxygen concentrators for their effect on aeration of drip irrigation water and also the response on crop and soil in short and longer terms are presented.

We have also developed methods for the monitoring of dissolved oxygen and bubble distribution in the line. The irrigation design and use of irrigation amendment that improve the distribution of aerated water in drip tape explored.

The recent work explore the for the use of hydrogen peroxide to optimise the performance of drip irrigation. We consider use of Nano bubbles as an opportunity for cost effective aeration of larger volume of irrigation water so that the technique can be extend to larger scale irrigation and furrow irrigated crops. We suggest an integrated approach is required for amelioration of the hypoxia and improved aeration of rhizosphere in irrigated horticultural crops.

Keywords:

Oxygation, Root respiration, Aerated irrigation, Soil aeration, Hypoxia

Five Year Nutrtitional Study of Apples in Commercial High Density Orchards

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The purpose of the study was to examine nutrient levels in commercial apple orchards planted in high densities. Leaf samples were collected from 12 commercial apple orchards located in the mid-Atlantic region of the U.S. over 5 years. The plantings were part of a uniform trial of 'Honeycrisp'/M.26EMLA (HC) and Cameo/M.9NAKBT337 (CA) established in 2008 at a spacing of 1.4x4.25 m (1709 trees/ha). Establishment practices at all sites were dictated by pre-plant soil and nematode tests and followed standard recommendations. Leaf samples were collected in mid-July to mid-August 2011 through 2015 and analyzed by the Agricultural Analytical Analysis Lab at Penn State. Analysis of variance was performed between the nutrient levels of the cultivars with mean separation by Tukey-Kramer test. Leaf calcium and potassium levels were lower in HC than in CA 5 out of 5 and 4 out of 5 years, respectively. Calcium levels in HC were below the minimum desired level, 1.3% dry weight, in 3 out of 5 years. The ratio of the percent leaf dry weight of N:Ca was always higher in HC than in CA and significantly higher 4 out of 5 years. Leaf levels of the Ca:Mg ratio was always lower in HC and significantly 4 out of the 5 years. Micronutrient levels of manganese were the only consistent differences between the cultivars. Manganese was always higher in HC and significantly so 4 out of 5 years. There were no consistent differences between the cultivars for leaf nitrogen, phosphorus, magnesium, (Mg+K):Ca ratio or the other micronutrients. Soil nutrient analysis was measured just prior to planting and again in 2014 at eleven of the sites. Levels of calcium, potassium, phosphate, magnesium and the cation exchange capacity (CEC) tended to drop but the extent of the drop varied by site.

Keywords:

apple, calcium, leaf analysis, soil analysis, Honeycrisp, Cameo, Malus x domestica, nutrition, fruit trees

Effect of Drought and Salt Stress on Plant Growth and Some Physiological Properties of Pepper Seedlings

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Cultured plants including vegetables are often exposed to some environmental stresses such as salinity, drought, high or low temperature, which either restrict or negatively affect the productivity. Plants grown mostly arid regions may be subjected to drought and salinity problems in soil during their life or in a part of its. However, current knowledge about physiological and growth responses for many plants in different intensities combination of drought and salt stress is still inadequate. To understand the adaptability of pepper seedlings to drought and salt stress, a greenhouse experiment was conducted on seedling growth and some physiological responses of pepper seedlings to different levels of salinity (S0: tap water, S1: tap water+75 mM dose of NaCl, and S2: tap water+150 mM dose of NaCl), irrigation quantity (W0: Full-irrigation, W1: irrigation with 75% of the W0, and W2: irrigation with 50% of the W0), and their combinations. Effect of salt and drought stress separately or together on pepper seedling growth was significantly important. Seedling growth including the shoot and root fresh and dry weights significantly reduced with increasing of salinity-drought stress. Salt and drought stress negatively affected seedling growth, but salt effect was greater than drought. Combined effect of salt and drought stress reduced further growth of pepper seedlings than separate stress conditions.

Keywords:

Water stress, Salinity, Capsicum annum, dry weight

Evaluation of a model-based irrigation strategy in professional soil-bound butterhead lettuce cultivation

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Background

An adapted Penman Monteith model, calculating actual water demand of the crop, proved potential as decision support system, optimizing water-use efficiency, preventing nutrient leaching and improving growing conditions. Additionally it can relieve doubt concerning irrigation quantity. Introduction of technology in horticulture is not self-evident, therefore hands-on experience is essential.

Objectives

By deploying the model on professional horticultural companies, growers gain confidence and learn how the model contributes to a smarter irrigation management. Ultimately we want to facilitate broad long term implementation.

Methods

The model was introduced to twelve Flemish greenhouses. During seventeen cultivation rounds, four growers compared model irrigation to irrigation based on soil sampling and own experience. The remaining growers applied the model as decision support for over thirty cultivation rounds year-round.

Results

Both strategies always resulted in high yield and crop quality, except for one round where severe damping-off occurred in both objects. While nine rounds did not differ in irrigation quantity and yield, three rounds saved more than 10% water without adverse effects. For two rounds more irrigation resulted in higher yield, while during two others more water was advised without obtaining higher yield. On loamy soils, growers gained much confidence in the model, as calculations closely resembled their own strategy or model implementation led to better results. On light sandy soils growers claim that more water is needed. To promote implementation in practice, sensor cost was reduced and a user-friendly web application developed. Because only solar irradiance, air temperature and relative humidity need to be measured, data collection was facilitated using climate computer or a custom developed sensor package. The application requires a minimum of input (planting date, start-stop model) and is freely consultable.

Conclusions

Growers confirmed usefulness in their irrigation management, providing that recommendations should be interpreted according to personal irrigation strategies.

Keywords:

irrigation model; decision support system; butterhead lettuce;

Effect on Water and Nitrogen Use Efficiency of a Fertigation Strategy aimed to Decrease Nitrate Emission from Greenhouse Tomato and Cucumber Crops growing on Semi-Closed Perlite system

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The goal of the present study was to evaluate water and nitrogen use efficiency of two vegetable crops (tomato and cucumber) grown on a greenhouse semi-closed soilless system and fertigated with two different strategies to reduce nitrate emission. The experiment was conducted in Almeria, Spain.

The compared strategies were: (A) crop water uptake was compensated refilling the mixing tank with nutrient solution at full strength, and flushing out the recirculating nutrient solution when NaCl accumulation exceeded 15 mM in tomato and 8 mM in cucumber; (B) like strategy A, but when NaCl accumulation reached 15 mM in tomato and 8 mM in cucumber, crop water uptake was compensated with fresh water just to reduce N–NO3 concentration below 1.0 mM before discharge.

Strategy B increased cucumber yield since EC values of the recycling solution were lower than those obtained with strategy A. In tomato, nitrate decrease did not affect yield but improved nitrate use efficiency.

Keywords:

Cucumis sativus, Lycopersicon esculentum, Water + nutrition, vegetables

Measuring nitrogen leaching in fields of commercial growers to enhance awareness in the Netherlands

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Nitrate concentrations in groundwater is in many vegetable crops too high, higher than the limit of 50 mg NO3-/l in the European Nitrate Directive. The exact level of nitrate leaching is influenced by local factors with climate, weather, soil type and groundwater level as the most important ones. Nitrate concentrations in groundwater are often monitored on national or regional level to fulfil requirements of the EU and hardly include vegetable crops. Most vegetable farmers have no idea about the level of nitrate leaching at their own fields. In a small pilot study we measured nitrate concentrations in the upper groundwater at five spots in two fields with leek at five farms in February 2017. Farmers helped in performing of the measurements. Ground water level, general soil fertility data, cropping data and fertilization data were recorded. Nitrate concentrations varied from 16 to 316 mg/l per field. There was a reasonable correlation between nitrogen input and nitrate concentrations in groundwater, but no correlation with groundwater level. Combination of cropping data and nitrate leaching gave farmers directly handles to change crop management, for instance taking better into account the nitrogen mineralizing from crop residues. More awareness among vegetable farmers of nitrate leaching at their own farm will stimulate them to change crop management to enhance efficient fertilization and reduce losses. Besides more information is gathered on nitrate leaching on vegetable farms. This winter the pilot will be scaled up to a larger number of vegetable farms. Data of this survey will be presented at the conference.

Keywords:

Nitrate leaching, leek, fertilization, management, nitrate directive

Water productivity in sustainable fruit orchard: adaptation strategies to climate changes

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The agricultural sector is the largest user of water resources, accounting for roughly 70% of all freshwater withdrawals at global level. By 2050, agriculture will need to produce 60% more food globally, however, current growth rate of agricultural demands on the world's freshwater resources are unsustainable. For this reason, improving the efficiency in the use of resources is crucial to sustainable agriculture.

This study summarises possible adaptation strategies in semi-arid environments aimed to improve water productivity in fruit orchards by using sustainable management techniques (e.g. no-tillage, supply of organic fertilisers, mulching of pruning residues, cover crops and guided irrigation), reducing the irrigation water applied. Through a life-cycle based approach, this paper also examines the effects of sustainable orchard management practices on Water Footprint (WF) in fruit tree orchards showing their potential to improve WF. To increase water productivity at farm level is necessary to increase the efficiency of irrigation system, the plant Water Use Efficiency (WUE) and optimize the irrigation management.

Results reveals that the increasing SOC contributes to an increase of the water holding capacity (at 2 mdepth) of about 1000 m3 ha-1 more under sustainable management than conventional. The optimization of irrigation management and the application of RDI during post harvest reduced the seasonal irrigation volume of about 1500 m3ha-1.

The sustainable management has a beneficial effect on natural resources (soil and water) conservation and restoration, implementing the water productivity of the agro-ecosystem and highlighting its mitigation role.

Keywords: guided irrigation, water footprint, Regulated Deficit Irrigation (RDI), Decision Support Systems (DSS)

Lettuce (Lactuca sativa var.) crop production using drip irrigation installed at different depths

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The objective of this study was to evaluate the yield, width and length of a leaf from a lettuce crop irrigated by a drip irrigation system, with irrigation tape installed superficially and at the subsurface at different depths: 10, 15 and 20 centimeters. The experiment was realized in a greenhouse and the texture of the soil used for the planting was Sandy clay loam, in plastic containers. To understand the treatments results determinations of humidity, pH, electrical conductivity (EC), nitrogen (N), phosphorus (P) and potassium (K) concentrations in a wetting pattern, were made in different stages of the crop cycle to evaluate their patterns. These parameters were obtained in a laboratory with samples taken of a grid made in a longitudinal cut at the center of the container. The nutrient solution and the irrigation conditions for the four depths of irrigation drips were the same. The nitrogen and potassium concentrations, founded in the soil of the four treatments, were superior to the ones required for a well-developed crop, but a similar phosphorus deficiency was observed. The soil water contents, pH and electrical conductivity (EC) resulted closer to the optimum values in the subsurface drip irrigation, particularly in the one with drip tape installed at 20 centimeters. An analysis of variance of the results using $\alpha = 0.05$, showed statistical differences in the yield of the studied treatments, and not the same way in the leaf's length and width. A Tukey's range test using $\alpha = 0.05$, indicated a higher yield in a subsurface drip irrigation, maximizing in the one with 20 cm of depth. A positive effect in the crop yield with subsurface drip irrigation was observed, propitiated by a better distribution of soil water content, pH valued, and electrical conductivity (EC), which are proper for a better nutrition assimilation.

Keywords:

Soil moisture, fertigation, wetting patterns, low pressure irrigation, subsurface irrigation, water, vegetables

Medium term evaluation of deficit irrigation strategies on orange trees growth and performance

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Deficit irrigation (DI) has been widely studied as a sustainable production strategy for citrus in dry regions. The influence of DI strategies on yield and fruit quality depends strictly on the severity of the imposed deficit, its duration and on crop physiological status.

Young 'Tarocco' orange [Citrus sinensis (L.) Osbeck] trees were managed from the planting date (2010) through the adoption of DI criteria, by using Regulated Deficit Irrigation (RDI) and Partial Root-Zone Drying (PRD). Surface and sub-surface drip irrigation systems contributed to enhance the performance of DI strategies. The numerous observations on physiological parameters (i.e. stem water potential, stomatal conductance) carried out on the deficit irrigated trees, contributed to assess the role di DI (RDI, PRD versus full irrigation) on plant growth (i.e. canopy growth, leaf size and elemental composition) and productivity (i.e. marketable production, fruit size and quality).

The results of the 7 years monitoring of DI effects on orange trees demonstrated that combination of RDI or PRD with sub-surface micro-irrigation system might represent a valuable water saving measure. The monitoring of fruit nutraceutical properties, fruit quality and yield showed the sustainability of DI application. DI strategies are efficient water saving strategies to increase WUE, while other physiological and growth parameters are almost unaffected.

Keywords:

functional traits, canopy, fruit size, anthocyanin, water use efficiency

Comparison of soil-N availability and greenhouse gas emissions in a field cultivated with legume or non-legume plants during the winter in a Mediterranean environment

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The aim of the present work is to improve N supply via alternative renewable organic sources in non-legume field crops grown organically. In particular, a field experiments was conducted at the experimental facilities of the laboratory of Vegetable Production at the Agricultural University of Athens. For this reason broccoli plants were cultivated under organic or conventional farming system. In the same experimental field faba bean plants, which were either inoculated with rhizobia strains of Rhizobium leguminosarum bv. viciae or not, were cultivated while a non-cultivated field was used as control. After the end of the first cultivation period, a rotation scheme with common

bean will be established. The focus of this work was on measures to facilitate the rapid transfer of biologically-fixed N from the legume crop to the following non-legume vegetable crop by testing the efficiency of the system in terms of biological N2-fixation (BNF) and its contribution to the total N needs of the tested non-legume vegetable crop. BNF was quantified using the 15N natural abundance method. The N levels in the soil (total-N, NO3-N, NH4-N) and plant tissues where monitored throughout the whole cultivation period for both crops. Furthermore, the impact of the different treatments on the levels of all other essential nutrients, were assessed. In addition, the impact of this legume- or non-legume vegetable cropping system on emissions of carbon dioxide (CO2), nitrous oxide (N2O), and methane (CH4) from the soil, which are considered the major greenhouse gases (GHG) contributing to global climate change, were also estimated.

Keywords:

Broccoli, faba bean, rhizobia, nitrous oxide, nitrogen

Bio-fertilizers effect on yield and growth characteristics of greenhouse green bean (Phaseolus vulgaris L.) under water stress conditions

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Scarcity of irrigation water is very common in the Mediterranean basin. In this study, the performance of the common greenhouse green bean (Phaseolus vulgaris L.) grown under water stress conditions and bio-fertilizers application was evaluated. Four bio-fertilizers were applied, namely: (1) Nomoren (mycorrhizal fungi; Glomus spp.), (2) Twin-Antistress (natural microorganisms based on Bacillus subtilis), (3) Bio Veramin Ca (an amino acid complex of vegetable origin with Aloe vera extract), and (4) EKOprop (a complex bio-fertilizer that contains Glomus spp, Bacillus spp., Streptomyces spp., Pseudomonas spp., Trichoderma spp.). The experiment was carried out during autumn of 2017, with experimental plots being arranged in a split-plot design. Bio-fertilizers were applied ten days after sowing for three times in 10 days intervals, whereas water holding started 21 days after sowing. During the growing period, plant growth (stem diameter, number of branches), physiological parameters (SPAD index, stomatal conductance, photosynthetic rate) and quality features (proximate analysis, organic acids and sugars content, phenolic compounds, antioxidant activity) were evaluated, while yield was evaluated twice at 50 and 70 days after sowing (fresh/dry weight of pods, number of pods per plant, pod length, 100 grain weight). Among the tested bio-fertilizers, the most increased fresh weight per plant comparing to control treatment was observed in EKOprop (373.74 g) and Nomoren (363.65 g) for regularly irrigated plots, whereas Nomoren

(280.64±152.24) and Twin-Antistress (237.16±174.2) gave the best results under water stress conditions.The results of the study indicate a significant effect of the tested bio-fertilizers on plant growth, yield and quality of green bean, with Nomoren showing the most promising results under regularly irrigated plants and/or under water stress conditions. In conclusion, bio-fertilizers can be considered as a useful means towards increasing plant growth and yield of greenhouse green beans, while specific products may alleviate the severe effects of water stress.

Keywords:

fresh weight, photosynthetic rate, antioxidant activity, Glomus spp

Evaluation of the lysimeter as tool for irrigation management on crop demand in soil-grown greenhouse cut-flower crops

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Despite that soil-less culture is the main cropping system used in Dutch greenhouse horticulture, many full-surface planted cut-flower species like chrysanthemum, lysianthus, as well as bulb and tuber crops like alstroemeria and freesia are still grown in soil. Since greenhouse production occurs year-round and at a high level, the amounts of water and nutrients used are much higher than in field crops. Thus emission of excess water and nutrients to the ground water and open surface water is likely to occur. The Dutch government is aiming to tackle the problem of emission at its source and the goal is zero nutrient and PPP leaching from greenhouses. For various reasons, collection and reuse of drainage water – as is mandatory for soil-less grow crops- is not an option for many situations. Therefore the nutrient and irrigation management has to be optimised, to prevent leaching as much as possible. One of the solutions to achieve the goal of diminishing leaching is the implementation of a lysimeter system. A practical lysimeter has been developed in close cooperation with growers to meet the requirements of the long lasting application in a commercial crop. Lysimeters were implemented at four commercial greenhouse holdings , with year round chrysanthemum, freesia, lysianthus and alstroemeria respectively. During approx. three years ,crop-, fertigation, and climate data were monitored. From these data evaporation and leaching was estimated using a modified ETo model. N and P surpluses were estimated from nutrient supply data and biomass analysis. The outcome was compared with the measured leaching from the lysimeter. The results revealed that the used ETo model for Alstroemeria fitted almost perfectly and was fairly good for chrysanthemum and Lysianthus, whereas for Freesia there were quite some discrepancies between simulated and real data. The ongoing results were reflected amongst the irrigation strategies used and evaluated together with the growers, which then was usually followed by adjustments to the irrigation strategy. It also revealed the substantial differences in adaptability among growers. Overall the results show that the leaching gradually diminished in time and that the lysimeter is a useful tool making leaching tangible for soil-grown crops.

Keywords:

Nutriënt Leaching, Drainage, Fertigation, Chrysanthemum, Alstroemeria, Freesia, Lysianthus.

Tightening Nitrogen Cycle in Cherry Orchards

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Management practices and climate have profound effects on soil nitrogen (N) supply and sweet cherry tree (Prunus avium L.) N requirements; however, these effects have not been fully explored. This article aims to (i) review existing knowledge on N management for cherry trees, and (ii) suggest future research direction for tightening N cycle in cherry orchards. In cherry, stored N accumulated the previous fall after fruit harvest supports early spring growth. Remobilization of stored N at budbreak increases N concentration in both shoots and spur tissues. Nitrogen affects cherry fine root production and mortality, and fruit quality, but usually does not affect yield (Glozer, et al., 2011; Bonomelli and Artacho, 2013). Nitrogen requirement by young cherry trees ranges between 9 to 53 kg N/ha with apparent N recoveries less than 15% (Bonomelli and Artacho, 2009). Nitrogen fertilizer type, rate, and method and timing of application need to be tailored to cherry's development stages. Although the status of N in cherry is usually assessed by post-harvest leaf analysis (Bonomelli and Artacho, 2013), but early season leaf analysis may allow growers to diagnose and fix deficiency. Post-harvest N fertilization increases N accumulation in both reserve organs and buds with no effect on cold hardiness and soluble solids in fruit. Pre-harvest N application must be carefully managed to avoid low fruit quality. Studies on effect of N management on cherry tree root distribution, soil microbial diversity and function, and nutrient cycling particularly in subsurface soil are scarce. Effects of sustainable practices such as mulch, compost and cover crops on soil N supply, and mobilization and distribution of N in cherry trees need further research. Finally, the impact of climate change and variability on soil N cycle and tree N utilization is unknown, and N regime for protected cultivation systems need to be developed.

Keywords:

mobilization, Nitrogen management, partitioning, research needs

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More than 60% of fresh apples produced in the United States are grown in Washington State. It is characterized as a semi-arid climate where water supply can occasionally be a limiting factor for apple production. Future climate change models predict that water limitations will increase hence improving water-use efficiency is critical for maintaining apple production in this region. The experiment was done at the Washington State University Sunrise Research Orchard in a drip-irrigated, two-year-old 'Honeycrisp' apple planting grafted to one of Geneva-41, Geneva-890, M.9-337 and Bud-9 rootstocks to investigate how rootstock genotype affects drought response of 'Honeycrisp' apple. The experiment was designed with two factors: rootstock and irrigation treatment. Soil water content was reduced to 50% of soil field capacity in the water-limited (WL) treatment starting three weeks after petal fall and soil water content was maintained at that level for 90 days. Mid-day stem water potential (SWP) and shoot growth were measured bi-weekly. At the end of the growing season, total leaf area was estimated using a handheld leaf area meter. At 45 days from the start of the experiment, shoot growth was significantly less for WL trees compared to the well-watered (WW) control. WL affected 'Honeycrisp' on G-41 and G-890 more than M-9 and Bud-9. Shoot growth was reduced by 60% for 'Honeycrisp' on G-890 but only 10% less for 'Honeycrisp' on Bud-9 for trees exposed to WL compared to the WW control. SWP was the lowest for G-890 exposed to WL reaching -1.65 mPa at the end of the growing season. Leaf area was 25% lower for WL Honeycrisp on Bud-9 compared to only 10% lower for WL Honeycrisp on G-890 relative to the WW control. In conclusion, Geneva rootstocks prioritize leaf area under WL whereas Bud-9 and M-9 limit leaf area under the same conditions.

Keywords:

Water stress, Malus domestica, vegetative growth, water, fruit trees

Fruit load effects on frond elongation and water potential of date palms

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Date palms are widely grown in Israel's Arava Valley which is a hyper-arid region. Thus, the cultivation of date palms in this region exclusively relies on irrigation application. In addition, fruit thinning is usually practiced in order to achieve big and high quality dates, by reducing fruit load early from fruit set. This research investigated the effects of fruit load treatments on water status and frond elongation of date palms under well-watered conditions.

Twelve date palms, 6 with fruits removed ("without fruits") and 6 non-thinned ("with fruits"), were fertigated with equal amounts of water, at levels sufficient for maintaining optimal soil water and nutrient conditions. Frond elongation was continuously measured by a novel device throughout the experiment. Additionally, the measurements of frond stomatal conductance, photosynthetic rate and water potential were intensively conducted during a full summer day campaign, prior to the harvest. The results showed that fruit load treatments affected frond elongation, as palms with fruits exhibited significantly lower frond elongation compared to those without fruits during fruit growing season. Frond elongation rate was minimized in the daytime when frond water potential was low, while it mainly occurred at night as frond water potential was resumed in both fruit load treatments. In addition, main frond elongation period was also determined and analyzed for representative time window selection. The elongation measurement period from 20 pm to 7 am was proposed as the representative time window which was consistent with the duration of frond water potential over -1 MPa.

As for the future work, the proposed representative time window will be validated and further used in order to develop a palm water stress indicator under different water and nutrient conditions to allow an optimal irrigation management regime.

Keywords:

Date palm; Fruit load; Frond elongation; Water potential; Representative time window

Does precision irrigation help to reduce water consumption in agriculture?

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We addressed the potential of precision irrigation to improve water use in agriculture, and the challenges that the users of this holistic approach face. We focused on two main aspects of precision irrigation: the irrigation strategy and the method for scheduling irrigation. We analyzed further the importance of designing properly the irrigation strategy, according to both the productive aim and

water availability. This was illustrated with an example of regulated deficit irrigation applied to a hedgerow olive orchard with high plant density in a semi-arid area of southwest Spain. Then, we focused on methods to assess water stress and to schedule irrigation with potential for precision irrigation, especially those relying on sap flow-, trunk diameter and leaf turgor pressure-related measurements. These methods, combined with remote imagery, are suitable for precision irrigation in commercial farms and orchards. So far, however, they have not been widely adopted by irrigation users. We analyzed the reasons behind this apparent lack of success, and how new technological advances may change that tendency. Thus, we had a look at the limitations of current plant-based methods, and also to efforts by large companies in both electronics and data transmission for the development of non-expensive, user-friendly sensors and related systems that may increase the popularity of plant-based methods among farmers and orchardists. Finally, we went into the concepts of water use efficiency, water productivity and water consumption to outline that the use of methods designed for a more rational management of irrigation does not necessarily lead to a reduction of agriculture water consumption at the regional level.

Keywords:

deficit irrigation, water productivity, water use efficiency, water stress, scheduling irrigation

Understanding nitrogen cycling in an irrigated deciduous permanent crop

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Recent advances in our understanding of nitrogen (N) cycling in permanent crops is the result of research in California on almond [Prunuc dulcis (Mill.) D.A. Webb]. Planted on over 400,000 hectares with optimum N application rates of 200-300 kg N per hectare, incremental increases in the N use efficiency of almond greatly reduces environmental impacts on air and water quality. The objectives of this study are 1) to summarize research outcomes related to N cycling on irrigated semi-arid and arid land using almond as a model system and; 2) to identify knowledge gaps to further refine our understanding of N cycling in permanent cropping systems. Patterns of uptake are based on whole-tree dynamics and in-season phenology including growth and development of annual fruit and leaf canopies as well as perennial woody biomass. Fertilization practices to maximize N use efficiency require careful irrigation scheduling when liquid N formulations are delivered to match plant demand. Fertilizer injection toward the end of irrigation leads to fewer N losses below root zone while use of low concentration nitrate-based fertilizers delivered in high frequency doses reduces nitrous oxide production. Overall, nitrous oxide emissions from almonds in California are lower compared to other global agricultural commodities. Progress toward integrating soil health into N management practices is ongoing with wide adoption of organic matter amendments. Despite the concern for impacting short-term soil N availability from the use of high C:N materials like compost, grower efforts to build soil organic matter demonstrate a commitment to long-term soil fertility.

Challenges in this research area still remain, mainly from lack of applied resources and technology to account for carry over effects from year-to-year as well as landscape and orchard-level soil heterogeneity.

Keywords:

nitrogen, N budgets, tree allocation, N losses, organic matter, almond, California U.S.A.

Responses of Processing Tomato (Solanum lycopersicon Mill) to Regulated Deficit Irrigation under Semi-arid Conditions: Yield and Quality

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Water is the most limiting factor among all the resources needed to sustain agricultural productivity. It is important to determine the highest yield and quality per unit of irrigation water used. A two year open-field experiments were conducted to study the effects of regulated deficit irrigation (RDI) on processing tomato in the semi-arid area. Yield, ascorbic acid, pH, titratable acidity in fresh fruit, fruit color, lycopene, β-carotene, dry matter, soluble solid content both in fresh and dry fruit, total and reducing sugar in dry fruit were analyzed. Irrigation was applied in three-day intervals, at ratios of 133% (T1), 100% (T2) and 66% (T3), as determined from the amount of total irrigation (IW)/total evaporation (CPE) for different three growth stages. The marketable fruit yield ranged from 27.82 t ha-1 to 73.26 t ha-1. All examined traits related to fruit quality (both in fresh and dry fruit) were affected by irrigation treatment depending on growth stages. The lycopene content varied between 24.09-41.54 mg 100 g-1 in fresh fruit and 137.73-229.56 mg 100 g-1 in dry fruit. The β-carotene content in fresh and dried fruit ranged between 6.0 to 9.0 mg 100 g-1 and 13.33 to 22.67 mg 100 g-1 respectively. RDI decreased the reducing sugar of tomato fruit but increased soluble solid content and total sugar. The ascorbic acid content showed an increase with shortage irrigation. Important results have been obtained in this study concerning the effects of deficit irrigation on fruit yield and quality characteristics of processing tomatoes by comparing different irrigation regimes consisting of combinations of growth periods and amounts of irrigation water applied.

Keywords:

Lycopene, β-carotene, ascorbic acid, tomato, RDI

Irrigation scheduling in a high density olive orchard using estimated stomatal conductance

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Achieving more resilient agricultural systems through regulated deficit irrigation (RDI) could contribute to achieve food security, using less water than other irrigation strategies. However, RDI needs a reliable and sensitive indicator of water stress. Although stomatal conductance (gs) is a good plant-based indicator because it reflects finely the level of water stress and photosynthesis limitations, its use for RDI faces a major limitation from the difficulty of being automatically and continuously monitored. Since a new approach to estimate gs automatically in the field has been reported based on sap flow, we conducted an experiment to schedule a RDI based on modelled gs in an olive orchard (summer 2017, Spain).

We had three treatments with four replicate plots each: two control treatments, one of them based on the Kc method (100CKc), and the other one based on the estimation of gs as a function of vapor pressure deficit and radiation (100Cgs), and one RDI treatment (45RDI) in which only 45% of the water added to 100Cgs was applied. Stomatal conductance modelled for 100Cgs was compared to gs estimated using sap flow measurements.

We found a good agreement between gs calculated through the two methods (R2=0.9, pgs (3722.6 m3·ha-1) than in 100CKc (4103.2 m3·ha-1) without affecting the trees water status (predawn leaf water potential was on average -0.67 MPa in 100Cgs), with no significant differences in fruit yield ($p>0.05$; 12633.0±3447.9 and 13290.1±1256.4 kg·ha-1 in 100Cgs and 100CKc, respectively). Yield in 45RDI was significantly reduced (7398.7±276.1 kg·ha-1) as it was the estimated gs, which was reduced around 70% compared to 100Cgs. We conclude that it is possible to schedule irrigation with automated estimations of gs in olive, opening the possibility for the determination of targeted levels of stress as a function of gs.

Keywords:

Fruit yield, Regulated deficit irrigation, Sap flow, Stomatal conductance, Olive

Effect of water stress in bromeliads with different photosynthetic metabolism

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Bromeliads are plants that occupy diverse environments such as mesic, xeric and ombrophilous and habitats from terricolous to extreme epiphytic. Among the adaptations to water deficit, the CAM metabolism (Crassulacean Acid Metabolism) allows better use of water when compared to C3 metabolism. The aim of this study was to evaluate the physiological and morphological parameters of two bromeliads with different photosynthetic metabolisms when submitted to different conditions of water stress. The experiment was carried out with 3 treatments: control, rehydration (water stress for 60 days and re-watering) and stress treatments for 30, 60 or 90 days. The destructive and non-destructive morphological and physiological parameters were evaluated at end of each 30 days. The species showed similar results, not showing differences for dry and fresh matter weight, and a rapid recovery of water contents in leaves on rehydration treatment. There was no change in Fv/Fm parameter between the species or treatments demonstrating the efficiency of the PSII photosystem of both species. We concluded that Aechmea fasciata (CAM metabolism) and Alcantarea imperialis (C3 metabolism) bromeliads are tolerant to low water availability and present rapid recovery of water stress when watered.

Keywords:

Aechmea, Alcantarea, water deficit, Crassulacean Acid Metabolism, CAM, C3

Effects of corn stem as a soil conditioner towards a green approach on waste management

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This study examined the period of time that is needed for corn stem to degrade into soil in order to provide a suitable pH condition for the next planting. Experiments were conducted in an open area to enable the treatment to blend with the natural environment similar to the actual practice. The corn residue which comprised corn stems and leaves were ground and mixed with soil in different concentrations (0 g/kg, 20 g/kg, 60 g/kg, 80 g/kg and 100 g/kg). The moisture content and pH

readings were measured for 60 days at 10 day intervals. Results showed that 20 g/kg was the most suitable concentration for a soil conditioner as it can constantly increase its pH value of R2=0.9457 and F value of 234.36 and maintain soil moisture content, R2 =0.4217 and F value of 164.82.

Keywords:

Corn Stem, Soil, Soil Moisture, pH, Soil Conditioner, Waste

Sunflower Production Under Deficit Irrigation Strategies

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Sunflower is one of a few crop species native to the United States and North America. California produces more than 90% of the hybrid sunflower seed grown in the US and approximately 25% of the world's supply of hybrid sunflower seed. Sunflower is commonly grown in arid and semi-arid regions with supplemental irrigation as the primary source of crop evapotranspiration. In this study, we estimated crop water needs for sunflower production in the low desert region of California and estimated the impact of deficit irrigation on crop productivity. The experiment was conducted on 4 and 6 ha fields at the University of California Desert Research and Extension Center, Holtville California. We estimated sunflower crop evapotranspiration (ETc) for two irrigation treatments (60% and 100% ET). We estimated actual crop water use using the surface renewal and eddy covariance methods. Sunflower crop coefficients for the fully irrigation treatment were determined and compared to FAO-56 published coefficients. The impact of deficit irrigation treatment on yield during the first year of the study was not significantly different from the fully irrigation treatment due to the presence of shallow watertable at a depth of approximately 2 m below the soil surface. We quantified the amount of water needed to grow sunflower in this arid climate and the potential contribution of shallow groundwater to sunflower ET.

Keywords:

Sunflower, deficit irrigation, groundwater contribution, crop water use

The effect of Silicon on the organically grown red cabbage transplants growth and quality

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Silicon is a mineral substrate for the growth and development of most plants.The purpose of the investigations was to look the effect of silicic acid on the red cabbage transplant growth and nutritional content. Another aim was to see whether there is an effect of silicic acid so early in plant development. The experiments in the greenhouse were carried out in the spring 2014 at the Estonian Crop Research Institute. There were two treatments: 1. stabilized silicic acid treatment; 2. Control. Seeds were sown on 17.04.17. Silicic acid treatments: First spray, when plants were growing was (21.04.14); second spray was 2 weeks after spray 1 (05.05.14); third spray as 2 weeks after spray 2 (19.05.14). First spray: 1ml silicic acid was solved in 0,5 liter clean (demineralized water, pH neutral) water; second spray: 2 ml silicic acid was solved in 1 liters clean (demineralized water, pH neutral) water; third spray: 2 ml silicic acid was solved in 1 liter (demineralized water, pH neutral) water. pH of spray solution was 5,5. Control plants were untreated. Red cabbage transplants were taller and stem diameter was greater in silicic acid treatment compared to control. The content of N, K and Ca were higher in silicic acid treated plants. P and Mg content did not show significant results after silicic acid treatment.

Keywords:

growth, height, nutrient content, red cabbage, stem diameter, transplant.

Measuring N partitioning in the soil-plant-atmosphere continuum

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Aquaculture has excellent potential for integration with agriculture as fish have a very low food conversion ratio, and most of the N they release is in the form of NH3 straight into the water they swim in. As with synthetic fertilizer, when fertigating field-grown crops with water from aquaculture a substantial proportion of it can be lost to drainage and volatilization. We hypothesize that more N will be volatilized from the root zone of plants fertigated with water from aquaculture than synthetic fertilizer, as there is a large amount of organic matter dissolved in the aquaculture water, supplying the carbon required for the bacteria that are responsible for the emissions.

A nitrogen balance was done on cucumbers grown in perlite and irrigated with water from 3 different aquaculture sources and a synthetically fertilized control. Each of these 4 fertigation treatments was used to irrigate plots at 6 different leaching fractions, resulting in 24 treatments.

The amount of N volatilized as calculated from the mass balance increased linearly with irrigated N but turned out to be unrelated to the source of the irrigation water. At the low irrigation levels

where the plants were more starved of N, the fraction of N lost to volatilization became extremely small, but the fraction of N lost to drainage increased. We have attempted to model the N uptake and transformation measured in the root zone by means of a numerical model that predicts water and solute transport (HYDRUS 2D/3D). Preliminary results show that it has good potential as tool for fertigation management.

Keywords:

integrated agriculture, aquaponics, nitrogen balance

Modelling N partitioning in the soil-plant-atmosphere continuum

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The integration of animal and plant production is important in order to reduce requirement for sequestered N and to deal with eutrophication issues due to N emissions from animal production. Water from aquaculture has excellent potential for fertigation as the fish release N in the form of NH3 straight into the water they swim in.

The water from aquaculture may vary drastically over time in terms of N concentration, and also includes a substantial amount of dissolved organic matter. In order ensure optimal fertigation for the plants irrigated, and to limit N emissions from the root zone we suggest using a robust numerical model that predicts water and solute transport (HYDRUS 2D/3D).

Data to calibrate the model was collected from a water and nitrogen balance done on cucumbers grown in perlite and irrigated with water from 3 different aquaculture sources and a synthetically fertilized control. Each of these 4 fertigation treatments was used to irrigate plots at 6 different leaching fractions, resulting in 24 treatments.

With the calibrated model we could predict the effect of the variable irrigation water N concentration on the amount of N available to the plant, leached, and lost due to volatilization. These preliminary results show that the HYDRUS model has good potential as a tool for fertigation management in integrated agriculture.

Keywords:

integrated agriculture, modelling, Hydrus

The olive tree responses to the application of different levels of water stress in an olive grove in Andalusia (Spain)

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During the year 2016 has been studied the productive response and growth parameters of an olive grove with a density of 408 ol / ha (7 x 3,5 m), variety 'Manzanilla de Sevilla', where applied 4 different degrees of water stress during a year. The trial, was carried in farm next to Cordoba (Spain).

Treatments applied by drip irrigation were: 1) 100% Etc, 2)controlled deficit irrigation with a medium water stress (CDI1), 3) controlled deficit irrigation with severe water stress (CDI2), and 4) rainfed, The contribution of rainfall has been lower than the annual average in the area, being especially scarce during the autumn, when that occurs oil formation in the fruit.

The amount of water provided were very different among treatments, having a direct relationship with the final size of the fruit as well as the oil yield, influencing the final quantity of oil produced per hectare.

All treatments departed from the same canopy volume and similar number of fruit per tree.. The experiment is designed in blocks at random with four repetitions, with control in the four central trees and having double-line saves.

It has been measured leaf water potential, the growth of the canopy volume, growth of shoots, evolution of size and oil of the fruit yield, as well as all the production parameters with a very interesting results of the effiency of the water use in olive trees.

Keywords:

Controlled deficit irrigation, olive tree, leaf water potential

Olive tree responses to different water stress levels in an olive grove in Andalusia (Spain)

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During 2016, the changes in production and growth parameters of an olive grove to 4 different degrees of water stress were studied. The olive trees belong to the 'Manzanilla de Sevilla' variety, had a density of 408 olive trees per ha (7 x 3,5 m) and was located near Cordoba (Spain).

The treatments applied by drip irrigation were: 1) 100% crop evapotranspiration (100% ETc); 2) controlled deficit irrigation with a medium water stress (CDI1); 3) controlled deficit irrigation with severe water stress (CDI2); and 4) rainfed (no irrigation). The contribution of rainfall during 2016 has been lower than the annual average in the area, being especially scarce during autumn, when oil formation in the fruit occurs.

All treatments departed from the same canopy volume and similar number of fruit per tree. The experiment was designed in blocks at random with four repetitions, with control in the four central trees and having double-line saves.

It has been measured leaf water potential (LWP), the growth of the canopy volume, growth of shoots, evolution of size and oil of the fruit yield, as well as all the production parameters.

The large differences among the provided water quantity treatments had a direct relationship with the final size of the fruit as well as with the oil yield. There is a positive correlation among the irrigation water amount and the final quantity of oil produced per hectare.

Keywords:

olive oil, Controlled deficit irrigation, olive trees.

Nitrogen responses of sweetcorn grown for the fresh produce market

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The ‘supersweet’ sweetcorn type which is predominantly sold as fresh cobs, accounts for the majority of UK production. The aim of the experiments was to provide improved nitrogen (N) recommendations for sweetcorn grown and harvested as cobs for the fresh produce market.

Eleven field experiments were carried out in 2013 and 2014 with six early, and five late-sown varieties drilled on commercial premises in the south of England. At each site the response to six rates and to three different timings of N fertilizer were studied. Measurements were made of soil mineral N to 90 cm depth, crop yield, and N and P offtakes were determined. Positive responses to N were recorded in just over half of the crops in the trial across both years, where soil mineral N (SMN) levels to 90cm were between 0 and 80 kgN/ha at drilling. At these SMN levels between 160 and 250 kg N/ha were needed to provide economically optimum yields. An increase in marketable yield of cobs was also seen at five of the experimental sites.

Nitrogen fertiliser recommendations for sweetcorn have been increased based on results of this project and are published in the AHDB Nutrient Management Guide (AHDB, 2017). These revisions are now in good agreement with international advice on N rates for maximum yield of sweetcorn at 220 kg N/ha (IFA,1992).

The experiments also indicated that Soil Nitrogen Supply (SNS) should be measured, rather than simple estimates from tables in the Fertiliser manual, especially for late drilled crops where additional mineralisation may lead to a greater amounts of SNS.

The financial support of AHDB Horticulture, and of Barfoots of Botley and A.E. Brown (Farms) Ltd. for hosting the field experiments is gratefully acknowledged.

Keywords:

nitrogen, sweetcorn, application timing, agronomy, fertiliser

Nitrogen recommendations for baby leaf salad crops

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The aim of this work was to provide UK growers with recommendations for optimal rates of fertiliser nitrogen (N) on baby leaf salad crops, which would allow them to optimise yield while remaining below limits for tissue nitrate concentration (TNC) set by the European Commission. Commission Regulation No 1258/2011 stipulates maximum TNC for various leafy vegetables. In 2012, limits were introduced for rocket (roquette, rucola), an important component of baby leaf salads, but which exhibit high TNC.

An initial survey of plant samples in 2010 showed that of eight commercial wild rocket (WR; Diplotaxis tenuifolia) crops, four would have exceeded limits for TNC. Experiments testing N response were carried out in 2011 (six sites) and 2012 (three sites) on WR, and three sites in 2012 on baby leaf spinach (BLS; Spinacea oleracea). This was followed by five N response studies in 2013 on baby leaf lettuce (BLL; Lactuca sativa). Experiments were located on commercial growers premises representing the main growing regions around the UK.

For WR, five out of nine sites showed positive responses to applied fertiliser N, and for BLL, only two out of five sites showed positive responses. Crop N offtakes were typically 115 kgN/ha for WR, and 65 kgN/ha for BLL. The highest N rates recommended for these crops would be 125 kgN/ha for WR and 65 kgN/ha for BLL. The response of BLS was similar to WR and the same recommendations apply. Where sites had sufficient soil mineral N at 0-30 cm depth at drilling (>84 kgN/ha) there was no crop response to applied fertiliser N.

Fertiliser recommendations were devised and included in the AHDB Nutrient Management Guide (AHDB, 2017) based on these results.

Keywords:

nitrogen, tissue nitrate, response, agronomy, wild rocket, spinach, baby leaf, lettuce, salad, fertiliser, soil mineral nitrogen

Drought stress affects yield, water use efficiency and quality parameters in hybrid and open pollinated lines of tomato (Solanum Lycopersicum L.)

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Water scarcity is a global issue and in the future will be exacerbated by increase in worldwide population and by climate change. Drought is one of the most important environmental factors that can affect plants' growth, influencing photosynthesis, productivity and secondary metabolism. In recent years, researches addressed the identification of water efficient traits from traditional open pollinated cultivars of vegetable crops. Tomato (Solanum lycopersicum L.) is one of the mostly cultivated crops with reported irrigation water use efficiency in the Mediterranean basin of 20 to 80 kg m-3. The present study addressed the adaptability of 14 tomato cultivars to drought conditions. In the first year, 14 tomato genotypes (7 hybrids and 7 open pollinated) were grown in an experimental field in which deficit irrigation treatments (respectively providing 100%, 50% and 25% ET estimated by Hargreaves equation) were applied. In order to identify drought tolerant lines, physiological parameters (e.g. stomata conductance, leaf temperature and water potential) were evaluated. At the

end of the growth cycle total yield, water use efficiency, polyphenol and flavonoids contents were determined. In the second year, the adopted experimental protocol and the agronomical, physiological and quality measurements were the same as in the previous year, but only 8 genotypes (4 hybrids and 4 open pollinated) were tested. In general, yield and water use efficiency of hybrids genotypes were higher than those founded for open pollinated genotypes. Among hybrid genotypes, only for one genotypes (namely Paki) no statistically significance differences in yield were highlighted between the three irrigation regimes. For two hybrid genotypes (namely Kirill and Strillo) yield at 50% and 100% ET irrigation regime didn't present statistical differences. Also quality's parameters were affected by drought conditions. Among the 14 genotypes, one open pollinated lines (namely Wild tomato Gelbe Johannisbeere) presented highest contents of polyphenols and flavonoids.

Keywords:

water stress; heirloom varieties; evapotranspiration; open-field

Effect of Furrow Irrigation with Plastic Mulching on the Fruit Yield, Quality and Water Use Efficiency of Pear trees

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Abstract: Furrow irrigation with plastic mulching can effectively improve the irrigation water use efficiency. The influences of furrow irrigation with plastic mulching on the fruit yield, quality and water use efficiency of pear trees was investigated in the pear orchard in Daxing District (Beijing, China). The experiment involved the flood irrigation (control), and the furrow irrigation with plastic mulching. The furrow size of treatment 1 (T1) was20cmof depth and30cmof width, while treatment 2 (T2)20cmof depth and40cmof width, treatment 3 (T3)30cmof depth and30cmof width, treatment 4 (T4)30cmof depth and40cmof width. The results indicated that the roots of pear trees mainly distributed in 40-60 cm depth soil layer in the vertical direction and at 150-170 cm from the tree row in the horizontal direction. The furrow irrigation with plastic mulching can reduce the irrigation amount. However, due to weak water retention of sandy soil in the experimental orchard and Lateral seepage, as compared with the flood irrigation, the soil water potential after irrigation of the furrow irrigation with plastic mulching was significantly lower, which resulting in the lower final pear yield. The pear fruit quality including the fruit firmness, total soluble solid, soluble sugar and titratable acid were not significantly affected by the irrigation methods. Because the partial root-zone irrigation effectively reduce the water amount and slightly affected the fruit yield, the water use efficiency was significantly improved by the furrow irrigation with plastic mulching. Among the furrow irrigation with plastic mulching treatments, the strongest water retention was observed in the treatment with 30 cm furrow depth and width.

Keywords:

furrow irrigation with plastic mulching, pear, fruit yield, water use efficiency, fruit quality

Identification of the Major Factors Affecting Pistachio Production in Saline Condition (Case study: Yazd province, Central Iran)

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Iran is known as the biggest Pistachio (Pistacia Vera L.) producer in the world. In 2014, for instance, Iran and the United States were the major producers of pistachios, together accounting for 76% of the total world production. However, while less than 1.4 tons pistachio is produced from each hectare of Iranian orchards that of US is more than 2.6 tons per hectare. At the same time, high yielding pistachio orchards with more than 12 tons per hectare are reported in Iran. This can be related to several different factors such as climate, geography, water shortage or quality, soil physicochemical properties as well as plant properties. The present study was aimed to evaluate the most important factors affecting the variations of pistachio production in salt affected commercial pistachio orchards of the central part of Iran as well as to identify the most limiting factors. For this purpose, twenty four representative commercial pistachio orchards, located in Yazd province, were selected and evaluated for the major yield-related parameters. Correlation matrix and Factor Analysis (FA) approaches were used to identify the most effective factors on pistachio production. Several different factors including climate (e.g. temperature, humidity, wind speed and etc.), geography (latitude, longitude and altitude), quality and quantity of water and soil resources (e.g. salinities of irrigation water and soil, leaching fraction, depth of applied water and etc.), soil physical properties (sand, silt and clay contents, bulk density, field capacity and PWP) as well as pistachio tree features (age, daily and seasonal evapotranspiration) were correlated with the pistachio yield. Results of this investigation showed that latitude (r=0.49), air humidity (r=-0.43), evapotranspiration (r=0.60), soil moisture at the PWP point (r=-0.30) and leaching fraction (r=0.33) parameters had crucial role on pistachio yield. Whilst, other parameters like sunshine hours, longitude and irrigation water pH had lower and insignificant effects on yield of the representative commercial pistachio orchards. Overall, irrigation system optimization, pistachio tree rejuvenation as well as increasing soil water holding capacity are recommended for improvement of pistachio production in the studied region.

Keywords:

Factor Analysis, Correlation Matrix, Pistachio, Salinity, Yield.

Nitrogen and Water Use Efficiency Under Rain-Fed Potato Agriculture: An Experimental Study

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Rain-fed potato systems in the Peruvian Central Highlands are not only limited by climatic condition but also by inorganic fertilization. The general objective of this research is to assess nitrogen (N) and water use efficiencies for different inorganic nitrogen fertilization levels in the Peruvian Andes (Mantaro Valley). Nitrogen use efficiency (NUE), nitrogen agronomic efficiency (NAE), nitrogen phenology efficiency (NPE) and water use efficiency (WUE) were estimated. During the 2015-2016 rainy cropping season, one experiment with different nitrogen fertilization (0, 100, 200, 300 and 400 kg N ha-1) was installed on a loamy soil. Destructive measurements were periodically performed in order to calculate leaf area index (LAI). Daily climate data were recorded.

Mean temperature was 12.8 °C, average air humidity 71.5%, average solar radiation 17.3 MJ m-2d-1, average wind speed 0.34 m s-1, total potential evapotranspiration 479 mm and total rainfall 462 mm, all calculated over the cropping season. No frost days occurred. The peak crop LAI were: 0.92, 3.71, 3.69, 4.75 and 4.59 m2 m-2 on average. Actual total evapotranspiration was adjusted to LAI measurements reaching 365, 500, 486, 502 and 504 mm. Fresh tuber yield (13.6, 41.9, 47.2, 55.0 and 52.3 ton ha-1) was significantly ($p < 0.01$) affected by nitrogen fertilization. Similarly, N application markedly improved NUE (43.2, 45.2, 48.5 and 47.9%) and NAE (31.9, 26.8, 20.8 and 22.0 kg kg-1N), however obviously decreased the NPE (89.8, 73.1, 58.3 and 55.9 kg kg-1N). WUE (3.7,11.5,12.9,15.1 and 14.4 kg ha-1 m-3) was indirectly affected by the different fertilizer applications, where water amount does not represent an important limiting factor.

Potato agriculture in the Peruvian Highlands, developed under low inorganic inputs, can be improved by rational use of nitrogen fertilization. However, further study should be performed to enhance it in an integrated approach.

Keywords:

nitrogen, raind-fed, water use efficiency, tuber yield

Reconciling physiological and agronomic effects of irrigation frequency

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Judicious use of scarce water resource requires an appropriate understanding of the amount and timing of water application, especially in regions with limited water supply. Using container-grown plants of basil (Ocimum basilicum) and tomato (Lycopersicum esculentum), the physiological (stomatal conductance, water relations and xylem ABA concentration) and agronomic (leaf area and biomass) responses of plants that received the same irrigation volume but at different irrigation frequencies were compared. While well-watered (WW) plants received complete daily replacement of crop evapotranspiration (ET), the other deficit irrigation (DI) treatments received either 75% or 50% ET of WW plants on a daily basis (frequent DI, FDI) or every 3-6 days (infrequent DI, IDI). Partial stomatal closure occurred in both DI treatments, but at the same whole pot water content, FDI plants had a higher stomatal conductance coincident with higher leaf water potential and decreased xylem ABA concentration compared to IDI plants. Despite these consistent differences in instantaneous leaf-level responses that are expected to decrease carbon gain of IDI plants, agronomic responses were more variable. In basil plants that received 75% ET during 3 x 6 day drying / re-wetting cycles during IDI, leaf dry weight of FDI plants was 33% higher than IDI plants. Conversely, in tomato plants that received 50% ET during 6 x 4 day drying / re-wetting cycles during IDI, FDI and IDI plants had the same shoot biomass. Current experiments aim to reconcile these divergent physiological and agronomic responses by measuring whole plant gas exchange (both transpiration and photosynthesis) throughout multiple drying / re-wetting cycles.

Keywords:

ABA concentration, deficit irrigation, irrigation frequency

Wastewater reuse in horticulture and its positive effect on peach tree (Prunus persica L.) physiology

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The efficacy and sustainability of treated wastewater use in horticultural crops was tested on potted peach trees subjected to three different irrigation treatments: i) irrigation with treated wastewater (WW); ii) irrigation with mains water, plus an addition of a slow release NPK mineral fertilizer (F); and iii) irrigation with mains water, without fertilizer (C). Each treatment was applied to 5 trees each from May 19th to September 5th. The wastewater (regulated by the Italian Legislative Decree No. 152/06) was collected from a civil wastewater treatment plant located nearby. Stem and leaf water potential and leaf gas exchange measurements where performed three times during the season (June, July and August). The increase in stem cross sectional area (SCSA), trunk cross sectional area (TCSA), shoot length and their relative absolute growth rate (AGR) were monitored for the entire experiment. Almost no significant difference in water relations and leaf gas exchanges was found among treatments. Allometry data enlighted a positive nutritional effect of wastewater, which allowed both trunk and shoot growth to be significantly higher than plants watered only with mains water. These preliminary results show how irrigation with wastewater did not cause any negative effect on the main plant physiological performances thus suggesting how secondary treated wastewater may be used as alternative source for irrigation without evident phytotoxic effects. Furthermore, the use of wastewater may reduce the need of mineral fertilizers, with consequent potential environmental benefits. Due to current water limitations it is really important to explore the possibility to use wastewater not as a waste, but as potential resource for agriculture.

Keywords:

Irrigation,water saving, water relations, leaf gas exchanges

Potential Strategies to Reduce Nitrogen Emissions to the Environment in an Intensive Cauliflower-Leek Rotation System: A Modelling Approach

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An optimally calibrated and validated mechanistic model for the simulation of soil-crop-climate interactions, emphasizing on nitrogen fertilization was used to predict nitrogen emissions to the environment in relation to the following scenarios for a cauliflower-leek rotation in Belgium. The reference system includes 4 N-dose fertilization rates, were dose 3 is matching standard commercial cropping conditions. The potential reduction strategies were threefold:

FF: a fractionated (by 4) weekly fertilizer application of each N-dose rate (with cumulatively the same amount)

SC: a soil cover or plastic mulch during winter fallow period preventing water infiltration and N-leaching between the harvest of leek and the start of cauliflower of the next rotation cycle.

FFSC: a combination of the two reduction strategies above

Overall, the crop yield got benefits from one or both the reduction strategies under the lower N-dose rates compared to the higher and especially regarding cauliflower cultivation from March to June. Looking at each crop cultivation each year, under the lower N-dose rates, yield increased due to fractionated fertilizer application (FF and thus FFSC), which seems to correspond better with the daily N-demand of the crop over its entire cultivation period. N-stress is reduced, especially at the later stage of crop growth.

Overall, a reduction in field nitrogen emissions to the environment is expected implementing one or both the reduction strategies. Whereas the FF system benefits the environment regarding ammonia volatilization (NH3) and nitric oxide (NOx) emissions, the SC system and even more the combined FFSC system reduces the nitrogen losses the most, regarding nitrate leaching (NO3) and nitrous oxide (N2O) emissions.

Nevertheless as a result of the full Life Cycle Assessment the environmental impact of the reduction strategy systems would be higher compared to that of the reference system. Main reason is the extra material and energy input to apply the reduction strategy which is not compensated (enough) by the expected yield increase and/or reduced field nitrogen emissions to benefit the environment.

Keywords:

nitrogen process, sustainability, open field horticulture

EFFECT OF WATER STRESS DURING REPRODUCTIVE STAGE ON TOMATO CROP YIELD AND SOIL WATER CONTENT

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To evaluate the effects of water stress on tomato at reproductive stages four irrigation treatments were established, based on the crop water requirements using the FAO methodology. At full flowering stage irrigation treatments were reduced in 50% until the end of harvesting season. T1 (150% to 75% of FAO ETc), T2 (100% to 50% of FAO ETc), T3 (75% to 33% of FAO ETc) and T4 (50% to 25% of FAO ETc). The experiment was laid out as a Latin square design with four treatments and four replicates. The soil in the experimental site is a loam with a depth of 70 cm and the following characteristics: saturation (SAT) 43%, field capacity (FC) 27% and wilting point (WP) 13%. Soil Volumetric water content at four depths (10, 20, 30 and 45 cm) was measured using a time domain reflectometry system (TDR) on the 3-hourly basis. Biometric destructive measurements were performed every 20 days to measure leaf area, dry mass production and nutrient content (NPK). Coverage images were taken on the weekly basis, resulting on a maximum coverage of 80%, 60%, 50% and 40% for T1, T2, T3 and T4 respectively. Tomato production was significantly affected by irrigation treatments. The highest yield was obtained with T1 (50.23 t ha-1), finding significant differences between this and T2, T3 and T4 yielding 25.98, 18.3 and 16.6 t ha-1 respectively. The three deficit treatments yielded below the national average yield (35 t ha-1), however for T1 produced 15 t.ha-1 additional yield, reducing water use in 90% compare to and average tomato farmer. In further research, we will use processed based mechanistic modelling to simulate the water transport dynamics under fertigation.

Keywords:

deficit irrigation, phenological stage, time domain reflectometry (TDR)

YIELD, WATER USE AND WATER USE EFFICIENCY OF SWEET POTATO UNDER DIFFERENT ENVIRONMENTS

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Sweet potato, often termed “the poor man’s crops”, is an important root crop largely produced by resource-poor farmers in the tropical and subtropical regions of the world. It has been reported to be adapted to a wide range of environmental conditions. Recently, there have been efforts to promote orange-fleshed sweet potato to address vitamin A deficiency among poor rural people. The study investigated yield, water use and water use efficiency (WUE) of three sweet potato cultivars (A40, A45 and 199062.1062.1) under different environments (Umbumbulu and Fountainhill in KwaZulu-Natal, South Africa) and agronomic practices (flat and peaked ridges). The experimental design at each site was a split-plot design arranged in completely randomised blocks with three replications. Water use was calculated as a residual of the soil water balance. At harvest, yield was determined as below ground fresh mass. Water use efficiency was obtained as the quotient of fresh yield and water use. Data from the two sites were analysed separately as they were not homogenous. Higher yield was observed at Umbumbulu (18 – 30 t ha-1) compared to Fountainhill (5.3 – 12.2 t ha-1). At Umbumbulu, A40 was the highest yielding cultivar under peaked ridges (30 t ha-1). At Fountainhill, A45 was the highest yielding cultivar under peaked ridges (12.2 t ha-1). At both sites, flattened ridges used more water relative to peaked ridges. At both sites, WUE was higher under peaked ridges. Cultivars performed differently at each site and under the different ridge types. Flattened ridges did not favour high yield and improved WUE. There is need to adopt different cultivars for different environments to improve yield and WUE across different environments.

Keywords:

root and tuber crop, tropical and subtropical regions, ridge type

Nutritional water productivity of selected sweet potato cultivars (Ipomoea batatas l.)

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Versatile crops such as sweet potatoes have potential to assist in addressing challenges related to food and nutrition security under conditions of water scarcity hence addressing the water-food-nutrition-health nexus. The objective of this study was to determine nutritional water productivity (NWP) of three locally bred sweet potato cultivars (A40, A45 and 199062.1) in response to varying water regimes. The experiment was conducted under controlled environment conditions (~33/18°C day/night and 65% relative humidity). The experimental design was a split-plot with water regimes [30% and 100% crop water requirement (ETc)] as main plots and cultivars (A40, A45 and 199062.1) as sub-plots arranged in randomised complete blocks, replicated three times. Cultivars A45 and 199062.1 are orange-fleshed sweet potato varieties (OFSPs) and A40 is cream-fleshed. Yield and water productivity (WP) were determined at harvest. Thereafter, samples were analysed for nutrient (energy, protein and fat) and micro-nutrient (β-carotene, calcium, zinc and iron) content. Results of nutrient content (NC) and WP were then used to calculate NWP. Yield did not vary in response to

water regimes nor were there differences (P>0.05) among cultivars. Cultivars 199062.1 (26.4 t ha-1) and A45 (16.7 t ha-1) out-yielded A40 (14.9 t ha-1). Similar to yield, WP did not differ significantly between water regimes and among cultivars. Based on mean values, WP was higher under 30% ETc relative to 100% ETc. This was attributed to yield maintenance under low water availability. Consistent with results of yield, 199062.1 (13.4 kg m-3) and A45 (8.8 kg m-3) had higher WP than A40 (7.5 kg m-3). Results of NWP for energy (E), protein (P) and fat (F) showed no significant differences between water regimes and among cultivars. The trend for NWP (E, P, F) was such that 30% ETc > 100% ETc and 199062.1 > A45 > A40 for water regimes and cultivars, respectively. NWP for calcium, zinc and iron mirrored this trend. However, NWPβ-carotene varied significantly (Pβ-carotene was higher at 30% ETc than 100% ETc. Cultivars A45 and 199062.1 had significantly higher NWPβ-carotene than A40. This confirmed that OFSPs are nutritious and offer greater diversity, especially in areas where Vitamin A deficiency is a problem. The fact that NWP did not vary significantly across water regimes implies that OFSPs have potential to contribute to human nutrition in water scarce areas. The use of NWP as a metric allows for an analysis of how agriculture can contribute to food and nutrition security under water scarce conditions.

Keywords:

Food and nutrition security, nutritional water productivity, water stress

Growth, physiology and yield responses of Amaranthus cruentus, Corchorus olitorius and Vigna unguiculata to nitrogen application under drip irrigated commercial production

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Amaranthus spp. (pig weed), Corchorus olitorius (Jews mallow) and Vigna unguiculata (cowpeas) are amongst the major African leafy vegetables of importance in South Africa. The aim of the study was to evaluate growth, physiology and yield responses of Amaranthus cruentus, Corchorus olitorius and Vigna unguiculata to nitrogen fertilizer application rates. Field trials were conducted at the Agricultural Research Council - Vegetable and Ornamental Plant Institute, South Africa over two summer seasons, 2011/2012 and 2012/2013. The trials were laid out in a randomized complete block design (RCBD) with three replications in 2011/2012 and nine replications in the 2012/2013 summer

seasons. The treatments were three nitrogen levels, viz. 0, 44 and 88 kg N ha-1 for the 2011/12 season and four levels viz. 0, 50, 100 and 125 kg N ha-1 for the 2012/13 season. Parameters measured included chlorophyll content index (CCI), chlorophyll fluorescence (CF), stomatal conductance (SC), leaf number, leaf area index (LAI) and biomass. The application of nitrogen at 44 kg N ha-1 (2011/12) and 100 kg N ha-1 (2012/13) resulted in significantly (PA. cruentus and C. olitorius. A further increase of nitrogen above 44 kg N ha-1 and 100 kg N ha-1 had diminishing returns. In V. unguiculata, the application of 50 kg N ha-1 significantly (P. In C. olitorius and A. cruentus higher leaf quality parameters (CCI, plant height, leaf number, biomass per plant, LAI and yield) following nitrogen application at 44 kg N ha-1 (2011/12) and 100 kg N ha-1 (2012/13) indicate that these crops can perform better with nitrogen fertilisation. In V. unguiculata, 50 kg N ha-1 improved leaf number; however, this did not translate to any fresh yield advantage implying that the optimum rate for nitrogen application might be lower than 50 kg N ha-1.

Keywords:

African leafy vegetables, yield, quality,

Optimization of irrigation and fertilization for improved nitrogen and water status as well as more accurate advice in pear (cv. `Conference´) production in Belgium

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Past research by the authors showed that a regulated deficit irrigation schedule whereby the soil water tension is allowed to decrease to -60 kPa during shoot growth, is beneficial for pear production

on sandy loam soils. A soil water balance model was developed for irrigation scheduling using soil parameters, weather forecast data, precipitation, irrigation, flow rate of the irrigation system and is the basis for the PWARO advisory service system for pear growers. This model calculates the average soil water content in the root zone on a daily basis and is verified regularly by measuring the actual water content in soil samples. Alternatively, Watermark granular matrix sensors can be used to monitor the soil water potential and schedule irrigation.

The normalized difference vegetation index (NDVI), calculated from Sentinel-2 satellite images, is strongly correlated with crop biomass. Similarly, calculation of the Re (Red Edge) NDVI was demonstrated to be strongly correlated with the stem water potential of pear trees. This research outcome was first translated into practice in 2017 as an extension service to the pear growers and aimed to delineate spatial heterogeneity in the orchard or apply variable irrigation.

Installation of irrigation systems is not common yet in Belgium despite the frequency and length of drought periods as experienced in 2016 and 2017. Pear growers irrigating their orchards, mostly chose drip irrigation and often combined this with fertigation. Especially nitrogen is dispensed via fertigation to reach not only a high yield but also a sufficient fruit firmness and green background color. However, due to nitrogen leaching into the surface and groundwater, nitrate concentration remains above the limit (50 mg NO3/L) at some locations in Flanders. The effects of reducing nitrogen fertilization are being investigated and results will be discussed.

Keywords:

regulated deficit irrigation, pear production, soil water balance model, soil water tension, normalized difference vegetation index, fertigation, nitrate concentration

Evaluation of tree transpiration of Pummelo 'Thong-Dee' under different environmental conditions

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Preferred presentation method:

Generally, tree transpiration is regulated by the soil moisture and evaporative demand. This experiment was to evaluate the tree transpiration of commercial pummelo 'Thong-Dee' by xylem sap flow method. This experiment was conducted in the farmer's plantation located in Kasetsomboon district, Chaiyaphum province, northeast Thailand. The age of 3 sampled trees was 6 years old with 74.8 cm in average of trunk girth. In each tree, the sap flow probe was inserted into the trunk at 30 cm above soil in the north azimuth. The data was recorded through the transient thermal dissipation method (10 minutes heating and 20 minutes cooling in a half hour period; TTD10) with a Granier's type probe. The data were calculated in both sap flux density and daily tree transpiration. The results showed that there was a fluctuation of tree water movement according to the soil moisture and air evaporative demand. It indicated that the soil drought decreased the xylem water transport, while the air evaporative demand increased tree transpiration. However, the tree transpiration was inhibited in the extreme evaporative demand condition. In addition, the diurnal sap flux density data confirmed that the limitation of sap flux density occurred in both soil drought and low evaporative demand conditions. Our result also found that the potential tree transpiration of 6 years old pummelo 'Thong-Dee' was higher than 100 L day-1.

Keywords:

water use, sap flow, soil drought, evaporative demand

Effect of Foliar Application of Calcium on Fruit Quality in Gold3 Kiwifruit

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The current nutrient management practices for gold kiwifruit (Actinidia chinensis Planch. var. chinensis 'Zesy002', commonly known as Gold3) need to be optimized in a sustainable manner to improve fruit production with an assurance of high quality standards and minimal impact on environment. This study is aimed to develop best nutrient management practices to optimize fruit quality and production and preserve environmental quality with cost-effective inputs. The soils in the Bay of Plenty, a prime kiwifruit growing region of New Zealand, are characterised by low availability

of potassium (K) and calcium (Ca) while being acidic in their native state. The on-going practice of high K inputs is adversely affecting Ca uptake by the kiwifruit vines. Low fruit Ca content is associated with reduced fruit firmness and shelf life in kiwifruit. This study was based on the hypothesis that foliar application of Ca after full bloom may increase Ca content in outer layers of the developing fruit and increase fruit firmness. Different formulations of Ca including commercial foliar products; CaCl2, Calbit C© (Valagro), CaltracTM 400 (YaraVitaTM), Pancal (Mantissa Corporation Limited) and StopitTM (YaraVitaTM) along with a control (water only) were used. All the Ca treatments were applied at 1 % Ca w/v and pH of all the treatments was buffered to 5.5. All foliar Ca treatments were applied five times at fortnightly intervals after full bloom. The results indicated that CaCl2 highly significantly (PPPP2= 0.78, P2 applications. Calbit C© showed a strong positive correlation (R2= 0.90, P

Keywords:

Kiwifruit, Nutrient Management, SunGold, Foliar, Calcium

Irrigation and nitrogen source management as a tool for improving nitrogen use efficiency in intensive Mediterranean horticulture

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The adequate management of nitrogen (N) in intensive agriculture should aim to increase the nitrogen use efficiency (NUE) (increasing yield per unit of N applied to the field) and reduce its losses through leaching. Irrigation and fertilization techniques used alone or in combination (fertirrigation) are powerful tools for this purpose. Here we evaluate two strategies aimed to increasing the NUE in intensive Mediterranean horticulture; i) the precise adjustment of the crop irrigation needs to cover losses by transpiration and evaporation of the soil water, and ii) replacement of the source of nitrogen, from the highly leachable nitrate to ammonium, which is also directly used by the plant, and retained in the clay-humus complex. Two field experiments, with escarole and melon, were carried out in orders to compared three treatments; i) irrigation and nitrogen management according to the farmer's criterion, i) the precision irrigation management with nitrogen according to the farmer's criterion and iii) precision irrigation management with the management of the nitrogen source. Measurements of water and nitrogen consumption by the plant, total and marketable yield,

fresh and dry shoot biomass, leaf water content, mineral tissue concentration, and nitrate and ammonium concentration at 30 cm depth of soil were made.The results indicate that precision irrigation is a key strategy to increase NUE. In addition, depending on the crop tolerance for ammonium, the fertilization source strategy should be also established

Keywords:

evapotranspiration; fertilization; irrigation; salinity;

Development and validation of a decision support system for irrigation scheduling of intensive vegetable crops based on soil evaporation and plant transpiration subroutines

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Nowadays, irrigation scheduling is most often based on a soil water balance that considers the reference evapotranspiration and crop coefficient approach. However, this procedure is based on an empirical data base of crop coefficients available from the literature and does not allow for taking into account field variability in canopy vigour, among other factors. A research on open-field vegetable crops (potato, lettuce and melon) has been carried out in south-eastern Spain to derive two model subroutines for separately determine soil evaporation and plant transpiration. Soil evaporation was modelled according to Ritchie (1972) assumptions, considering the ground cover fraction, while plant transpiration is derived from the approach described by Rana and Katerji (2009). The water balance model can be coupled with ground covers and Normalized Difference Vegetation Index data obtained from Sentinel-II satellite images. The model has been implemented in a commercial decision support system that also considers weather forecasts and was successfully tested during two experimental seasons and sites. There, different irrigation scheduling methods were compared, including the system-based and the standard farmer practice. The model mimics quite well the farmer´s irrigation scheduling without employing on-the-ground sensors. However, significant water savings were not achieved because the farmer's approach was already well adjusted to the crop water needs and because of the leaching fraction applied due to the high salinity levels of the irrigation water employed in the area. Further developments are needed in order to better estimate the water leaching fraction and determine evapotranspiration under deficit irrigation conditions

Keywords:

evapotranspiration, remote sensing, salinity, weather forecasts

Leek production in conventional and organic arable-vegetable rotation in the Netherlands: effects on yield, nutrient balances and nitrogen leaching

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Leek production, one of the most important vegetables grown in the South East of the Netherlands, is supposed to have high nitrogen leaching because of the shallow rooting, late harvest, high nitrogen requirement and cropping on sandy soils.

Leek production was part of a farming systems experiment with two conventional and one organic farming system with arable and vegetable crops on sandy soils. One conventional farming system (LOW) had a low organic matter input, by crop residues and green manure crops mainly. The other conventional farming system (STANDARD) had a regular organic matter input with the use of cattle and pig slurry as well. The organic system had a high organic matter input because of the use of farm yard manure and cow slurry. Data of crop yield, nutrient balances and nitrate leaching are presented of the period 2011-2016.

In the LOW system, crop production was 5% lower than in STANDARD. Nitrogen surplus was higher in STANDARD than LOW, Phosphorus surplus was about equal and Potassium surplus was higher in LOW than STANDARD. Nitrate leaching was comparable in STANDARD and LOW, but both above 50 mg/l. Other indicators of nitrogen leaching as mineral nitrogen content in soil and nitrogen surplus indicate that leaching risk in STANDARD is higher than in LOW.

Leek production in the organic systems was low because of pests and diseases. However, in years with low disease pressure yields were almost comparable to the conventional yields. Nutrient surpluses of N, P and K were high in the organic system. Nitrogen leaching was below 50 mg/l in the organic system although the other indicators were comparable to the conventional systems.

A dilemma still exist between crop yield and nitrate leaching in the conventional systems. The organic system gives despite the relative low yield good results on nitrate leaching.

Keywords:

Leek, organic matter, fertilization, yield, nutrient balance, nitrogen leaching

The effects of NaCl stress and excess boron on enzymes involved in the nitrogen assimilation pathway of Zea mays L. amylacea ecotype from the Lluta Valley (Arica-Chile)

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The Lluta valley in northern Chile is an important agricultural area affected by both salinity and B toxicity. Zea mays L. amylacea, an ecotype of sweet corn that has arisen as a consequence of the seed selection practiced in this valley, shows a high tolerance of high salt and B levels. The present study reports the behaviour of the nitrogen metabolism in Z. mays amylacea when grown in the presence of salt and B. The interaction between B and salt was studied after 20 days of treatment at 100 and 430 mM NaCl, assessing changes in nitrogen metabolites and the activity of key nitrogen-assimilating enzymes. In this sense, in non-saline conditions, the presence of excessive B favored higher nitrate and ammonium mobilization to the leaf, increasing the activities of NR and GDH, but not of GS. Salinity induced a decrease in the shoot nitrate content, whereas in the roots the nitrate content was not changed. The results suggest that NR is regulated by NO3- availability in the leaves and therefore by low NO3- loadinginto the root xylem and nitrate translocation to the shoots. Thus, close relationships between leaf NR activity, nitrate uptake and stomatal conductance were observed. The increment of Ala and Ser, the major amino acids in amylacea, under low-salinity conditions indicates a photoprotective role of photorespiration. The inhibition of glutamine synthetase (GS) and glutamate dehydrogenase (GDH) also occurred only at high salinity, but the remaining GS and GDH activities were able to provide enough amino acids for synthesis of proline, which would act as an osmolyte under highly-saline growing conditions.

Keywords:

nitrate reductase; glutamine synthetase; glutamate dehydrogenase

Effects of alternate drip irrigation and nitrogen fertilization on photosynthesis, yield and water-nitrogen use efficiency of cucumber in solar greenhouse

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Effects of alternate drip irrigation and nitrogen fertilization on photosynthesis, yield and water-nitrogen use efficiency of cucumber (Jinyuan 578) in solar greenhous were investigated. The experiment utilized the split-plot design with drip irrigation as main plots and nitrogen as subplots. The main plots was drip irrigation (alternate drip irrigation, A, and conventional drip irrigation, C), the subplots was the amount of nitrogen (0 level: 0 kg N/hm2,1 level: 320 kg N/hm2 and 2 level: 640 kg N/hm2). So there were six treatments in total, designated A0, A 1, A 2, C0, C1, and C2, respectively. The results showed that: (1) The content of chlorophyll a and chlorophyll b in A2 increased by 7.4% and 12.8% compared with C2. (2) Pn and Gs under A1 and A2 were significantly higher than that of other treatments; compared with A1, qP under A2 decreased by 3.5%, both PSII and ETR decreased while NPQ increased; compared with A, QA pool of photosystem II reaction center under C decreased, and the transport of electrons from QA to QB was blocked. (3) The soluble sugar content of A1 was significantly increased by 21.3% compared with C1; the nitrite content in cucumber fruits of A1 decreased by 44.3% compared with C1, the nitrite content in cucumber fruits of A2 decreased by 47.2% compared with C2. (4) The yield of A1 increased by 12.9% compared with C1, and the yield of A2 increased by 11.1% compared with C2; the WUE of A1 was significantly increased by 16.6% compared with C1, the WUE of A2 increased by 14.7% compared with C2; the ANUE of A1 increased by 45.4% compared with C1, the ANUE of A2 increased by 215.7% compared with C2; there was no significant difference in yield and WUE between A1 and A2, while the ANUE of A1 increased by 44.1% compared with A2. In conclusion, A1 can significantly increase the Pn of cucumber leaves, significantly increase the yield and improve the quality and improve the use efficiency of water and nitrogen, so A1 can be used as an effective water-nitrogen management mode in solar greenhouse to achieve the goal of "water-saving and reducing fertilizer" cultivation.

Keywords:

cucumber; alternate drip irrigation and nitrogen fertilization; yield; water-nitrogen use efficiency

Plant nutrition as a function of irrigation water quality

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Water scarcity is ever increasing the need and desire to utilize non-conventional sources of water for irrigation. Water for irrigation today includes brackish groundwater, recycled wastewater and desalinated water. Each type of water has a unique chemical composition, requiring independent consideration regarding management of crop nutrition. Water quality/composition has influence and repercussions on interactions with fertilizers, soil chemistry and nutrition, and of course, on plants.

In order to adapt the fertilization regime to irrigation water quality the contents of inorganic macro and micro essential nutrients have to be taken into account. The most conventional sources of irrigation water are groundwater, lakes and rivers. In many regions, this type of water contains calcium, magnesium, sulphur and boron. However, in other regions such water sources can be poor in these nutrients. In brackish groundwater one may find also potassium and chloride whereas in recycled wastewater, nitrogen, phosphorus and micronutrients are found. Contrastingly, desalinated water contains only calcium and boron.

High concentrations of essential elements and other ions affect the uptake of nutrients by plants. For example, brackish water and recycled wastewater contain high concentrations of sodium, which might inhibit potassium and calcium uptake and high concentrations of chloride and sulphate which might inhibit nitrate uptake by plants. In addition, Irrigation with water containing high mineral concentrations requires a leaching fraction which, consequently, increases amount of applied fertilizer and may create environmental hazards.

The soluble organic matter found in recycled wastewater can contribute nitrogen and phosphorus but the mineralization rates of these nutrients are complex and it is difficult to assess their contribution to plant nutrition.

The talk will address these issues and bring examples and case studies from horticultural crops including fruit trees, fresh herbs and vegetables.

Keywords:

brackish, recycled, desalinated, fertilization

Effects of foliar application and fertigation of potassium on yield and fruit quality of grapevine cv. Superieur Seedless

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Fertilization of temperate fruit trees, such as grapevine (Vitis spp.) is an important tool to achieve maximum yield and fruit quality. Potassium is a key element for grapewine quality contributing to adequate berry maturation, concentration of sugars, synthesis of phenols and the regulation of pH and acidity. In addition, through its mobility in the phloem and xylem, K is important in the transport of solutes, the partition of assimilates, and the synthesis of polyphenols responsible for fruit color and aroma. The aim of the present work is to study the effect of different treatment of potassium mineral nutrition on grapevine (cv. Superieur Seedless) yield and fruit quality. Five combined treatments were applied: (T1) 75% of tree requirement by fertigation and 25% by foliar spray using potassium sulphate fertilizer; (T2) 75% of tree requirement by fertigation and 25% by foliar spray using K Leaf fertilizer; (T3) 75% of tree requirement by fertigation and 25% by foliar spray using nitrate of potash fertilizer; (T4) 100% of tree requirement given by fertigation using K Leaf fertilizer; (T5) Control without potassium mineral nutrition.

The potassium (K) fertilization induces a slight increase in yield compared to control. (T2) treatment is more efficient and shows a better yield. Potassium treatments improved grape and berry diameter and weight. Also, potassium fertilization increases the total soluble solid. Potassium applied by treatement (T3) significantly increased the fruit diameter and grape weight compared to the control. The greatest total soluble solids were measured on berries from trees that received 75% of tree requirement by fertigation and 25% by foliar spray using nitrate of potash fertilizer (T3) and 75% of tree requirement by fertigation and 25% by foliar spray using K Leaf fertilizer (T2).

Our results showed that potassium mineral nutrition improved yield and fruit quality of grapevine. Yield, fruit diameter and total solid soluble were enhanced when the tree potassium requirements were given by foliar spray combined with fertigation with L Keaf or nitrate of potash fertilizers.

Keywords:

Grapevine, Potassium, Fertilization, Foliar spray, Fertigation

Initial development of pumpkin in presence of biological agents

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The pumpkin crops is very cultivated and consumed in Brazil. The aim this work is to verify the initial development of pumpkin plants cultivated on substrates with and without a presence of biological agents. The experiment was conducted in protected cultivation at the Southwest Bahia State University, Brazil, in period of 10/16/2017 (planting) on 10/11/2017 (evaluation). The design was a completely randomized design with three replicates, in a 2x4 factorial, comprising two substrates, in the presence and absence of two biological agents as soil conditioners (Trichoderma longibrachiatum, Trichoderma harzianum) and humic and fúvic acid as positive control and absence of biological agents as negative control, as seeds were planted in pots (15x28x08 cm), each repetition consisted of five pots, totaling 120 pots. Samples were collected from substrates for initial analysis

and at moment of the evaluation in order to compare their results. In relation to plants as evaluated the following characteristics: Chlorophyll "a", "b" and total; branch length (cm); lap diameter (mm); root length (cm); fresh weight of shoot and root (g); number of leaves and dry weight of shoot and root (g). At end of the evaluations was observed with the soil with manure presented the significant difference for the characteristics of the branch; lap diameter; root length; fresh and dry weight of shoot and root, and the biological agents and as interactions did not present significant difference in the emissions of notes.

Keywords:

Cucurbita moschata, Trichoderma sp., soil conditioners.

Monitoring and improving irrigation efficiency in an organic olive farm in cyprus

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Water limitations for irrigation needs in agriculture in the Mediterranean are expected to increase in the future. The main objectives of this study are the determination of the farmer's irrigation practices in Cyprus through participatory research and the development of improved irrigation scheduling methods. Irrigation practices were observed in an organic olive tree orchard, during the period of 2016-2017. 'Koroneiki' variety was selected as a well-adapted and nutritionally important variety grown in the Mediterranean. Soil moisture sensors were used in the root zone of four trees for the evaluation of soil moisture. The sensors were installed at three depths: 10, 20 and 40 cm and data were recorded hourly. A meteorological station for monitoring weather conditions observations was also installed in the field. From the data obtained, detailed soil moisture change in the soil through the year was defined. Fast reduction of soil moisture particularly within 24 hours after irrigation was observed. Additionally, further reduction reaching the pre-irrigation levels occurred within 48 hours. Those results indicate water losses through drainage to deeper soil layers during irrigation. During the period between November 2016 to April 2017, precipitation completely fulfilled the irrigation needs. The weather conditions followed the common seasonal pattern without extreme events. The results were presented to the farmer and options for improved irrigation scheduling in the coming season were discussed. It can be concluded that participatory soil moisture monitoring is a promising approach for olive tree orchard management in the Mediterranean. New practices might avoid excess water loss and increase the efficiency of the system.

Keywords:

olives; soil moisture; irrigation practices; participatory research

Opening stomatal agriculture may increase yield up to sixty percent on processing tomato

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Sustainability may concern development of techniques aiming maximize photosynthesis to reaching bigger efficiency of commercial production. The first step in ensuring photosynthetic efficiency is to keep longer stomatal opening. Stomatal opening require two conditions: Firstly: - ensure constant supply of water throughout the day and cycle; - Secondly: - guarantee a balance among temperature, luminosity and ventilation inside the canopy in order to reduce the vapor pressure deficit in crop. Aiming to evaluate the impact of the first condition, it was sought to stimulate root deepening, to remove the effects of the fluctuation of the water supply due to the temperature variation in the first layers of the soil throughout of the day. Thus, the effects of irrigation frequency on productivity, photosynthesis, stomatal conductance, leaf temperature and root growth were studied. The experiment was carried out in the Plant Science Department of the Federal University of Viçosa Brazil, from June to September 2016. The processing tomato hybrid 'Inovatr' was used. Treatments - frequency of irrigation: daily (T1), every three days (T2), every five days (T3) and every seven days (T4). The productivity in T1 was lower (89.0 t ha-1) than T4 (153 t ha-1). The leaf temperature was significantly lower in T4 than in T1. The photosynthetic efficiency increased linearly from T1 to T4. On the other hand, stomatal conductance was lower in T4, guaranteeing an increasing water use efficiency from T1 to T4. Observed in T4 more density, length and specific area of the root in the layer of 20 to 100 cm. It is concluded that T4 with deeper roots, greater water supply, and thus greater stomatal opening made possible reach lower leaf temperature, greater photosynthetic efficiency and, therefore, greater sustainable production.

Keywords:

sustenability, photosynthetic efficiency, productive efficiency.

Screening Tomato Genotypes Under Combined Water and Nitrogen Stress

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Despite water and nitrogen (N) being two of the most important factors limiting tomato production, only a few studies have addressed the complex interactions between both abiotic stresses and new insights are required to improve their use efficiency. In this study, we aimed to screen the variation in water and N use efficiency (WUE and NUE) in tomatoes grown under combined stresses. To this end, a greenhouse experiment was conducted with 50 tomato genotypes (encompassing a range of genotypic and phenotypic variability that contains heritage varieties, hybrids, wild accessions, and cv. 'Moneymaker' and 'Microtom' as references). Two-weeks after germination, plants were transferred to pots with 0 to 1.5 mm grade vermiculite and were divided into two groups: (1) control plants that were irrigated to field capacity with a complete nutrient solution; and (2) stressed plants that were irrigated to field capacity with an N deficient solution (20% N) and were further subjected to water stress. Control plants were re-watered daily (till substrate field capacity), whereas stressed plants received no more water following transplant. The experiment ended when the stressed plants from each genotype reached 50% of the substrate water capacity. At this time point, several morphological and physiological parameters were accessed including plant height, leaf area, dry weight, stomatal opening (porometer), photosynthetic efficiency (Fv/Fm), chlorophyll, flavonols, anthocyanins, and N indexes (dualex). Plant temperature (thermal camera), leaf curling and N deficiency symptoms were also evaluated. Shoot/root ratio, relative water content, proline, and nutrient content were determined. From the final dry weights/N content and the known amounts of water/N supplied, WUE and NUE were estimated. WUE and NUE largely varied between genotypes, offering good prospects for plant breeding. Future work should focus on understanding the morphological, physiological and molecular basis of WUE and NUE.

Keywords:

genotypic variation, Solanum lycopersicum, nitrogen use efficiency, water use efficiency

Non-structural carbohydrates as physiological indicators to almond nutritional status

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Almond cultivation is expanding worldwide, due to a steady price and a growing market. Now, irrigation, fertilization, and their integration (i.e. fertigation) need to meet the physiological and environmental requirements of new grounds. Yet we lack physiological indicators to guide precise nutrient application. In search of such, we postulated that almond trees would alter their photosynthate management if their nutritional status changed. Hence, determined to develop a

physiology-based standard for almonds nitrogen (N) application, we set to investigate how almonds preformed, and altered their carbohydrate management at 10, 60, and 150 mg N L-1 in irrigation. We identified the transition of starch to soluble sugars in N deficient roots as they expanded to optimize uptake, and we quantified the loss of total carbohydrates in the ever demanding canopy of N rich trees. This represents a first and promising step in our work to model whole-tree carbon management and apply it to field work.

Keywords:

fertigation, nitrogen, photosynthesis, Prunus dulcis

Deficit Irrigation and Humic Substances Residuals Affected Watermelon Yield and Soil Properties

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Water stress conditions caused by climate change and low soil water retention are major threats to agricultural production. It is widely accepted that soil containing more organic matter has higher water holding capacity which in turn affects plant water use efficiency (WUE). However, related research is limited under water stress conditions in horticultural crops. In this study, we applied 50% (deficit) and 100% (well-watered) evapotranspiration (ET) irrigation rates in the field, with or without humic substances residuals in the soil (HS or control), and tested their effects on seedless (triploid) and seeded (diploid) watermelon yield, quality and soil property changes. Deficit irrigation decreased triploid and diploid watermelon total yield by 19% and 23%, respectively. HS significantly increased triploid watermelon early yield by 73% compared to control, especially under deficit irrigation (115%). HS also increased triploid total marketable yield by 20%. Compared to the well-watered treatment (100%-ET), deficit irrigation (50%-ET) decreased yield of mid-size triploid (5-9 kg) and large-size diploid (>9 kg) watermelon fruits; while HS increased yield of large-size fruit (>9 kg) in both triploid and diploid watermelon compared to control. Neither HS nor irrigation affected watermelon quality, except that 100%-ET irrigation rate significantly decreased triploid fruit firmness in the control, but not in the HS treatment. HS soil residuals significantly increased soil organic carbon (24%), which was positively associated with an increase in WUE for triploid watermelon ($P = 0.02$). These results indicate that soil organic amendments with humic substances have the potential to improve plant WUE and mitigate water stress in field conditions.

Keywords:

humic acids, water use efficiency (WUE), soil organic carbon, triploid and diploid watermelon

Water Stress Promotes Phenolic compounds and Antioxidant Accumulation at the Expense of Growth, Yield and Vitamins in African Nightshades

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Water stress is one of the abiotic stresses that limit growth and yield in leafy vegetables. On the other hand, some studies have shown that manipulation of water/irrigation can be used to enhance accumulation of health promoting compounds produced by the plants in response to stress. A study was conducted to determine the effect different watering levels on growth, yield and health promoting compounds in African nightshade (Solanum nigrum). Individual plants were grown in polythene pots and watered daily for two weeks and thereafter subjected to four watering levels (40% pot capacity, 60% pot capacity, 80% pot capacity and 100% pot capacity). The treatments were laid out in a randomized complete block design with three replicates. Effect of the treatments on growth was determined from the leaf number, leaf area, plant height and number of branches. Leaf yield was determined from the fresh leaf yield 14 weeks after emergence. Vitamin A and C, total phenolics and antioxidant levels were determined using standard protocols from freshly harvested leaves 14 weeks after emergence. Data collected were subjected to analysis of variance and means separated using the least significant difference test at $p \leq 0.05$. Plant height, leaf area, number of branches per plant, number of leaves per plant, total leaf yield, vitamin A and C decreased linearly with reduction in soil moisture levels. Reduction of moisture level from 100% pot capacity (PC) to 40% PC resulted in a significant reduction in all growth parameters measured including plant height (78.1 cm to 22.2 cm); leaf area (257 to 64.3 cm2), number of branches (13.9 to 4.38) and leaf number per plant (45.4 to 20.3). The fresh leaf weight per plant decreased from 47.39 to 8.93 grams per plant for 100% and 40% PC respectively. Phenolic content and total antioxidant activity significantly increased by 34.5 and 45% with the reduction in soil water levels from 100% to 40% PC respectively. These results show that while adequate water supply is important for growth and yield of African nightshades, controlled water stress can be used to promote accumulation of some health promoting compounds such as antioxidants.

Keywords:

African nightshade, quality, water stress, antioxidants

Effects of super-absorbent polymers with different granularities on the physicochemical properties of substrate and the growth of lettuce seedlings

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The suitable granularities of super-absorbent polymers (SAP) in substrate for the growth of lettuce seedlings was studied. The experiment was conducted by two difference granularities 40 mesh (T1), 20 mesh (T2) SAP in substrate and substrate without SAP as control. The effects of different granularities SAP on the physicochemical properties of the substrate, morphological indexes and the physiological indexes of lettuce seedlings were investigated. The results showed that the electrical conductivity (EC) value of T1 and T2 respectively increased by 5.53% and 4.63% compared with the control, and the pH of T1 and T2 respectively increased by 13.23% and 0.73% compared with the control. The saturated water absorption of T2 increased by 9.62% compared with the control; the saturated water absorption capacity of T1 and T2 increased significantly by 6.95% and 5.85%. The fresh weight, dry weight, root shoot ratio, and seedling index of T1 and T2 were increased significantly. The biomass of T1 was significant increased. The chlorophyll a, chlorophyll b and total chlorophyll content of T1 were significantly increased. The net photosynthetic rate and transpiration rate of the lettuce seedlings were significantly increased in T1 and T2. The net photosynthetic rate of T1 was increased by 14.82% compared to T2. The results showed that 40 mesh and 20 mesh SAP in substrate can significantly promote the growth of lettuce seedlings, and 40 mesh SAP in substrate for lettuce seedling was recommend.

Keywords:

lettuce; super-absorbent polymers; seedling growth; substrate

Improving Soil and Water Management for Agriculture: Insights and Innovation from Malta

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Maltese soil resources are a precious and finite natural resource of great agricultural, environmental, and cultural value. They have been subject to human influence over a considerable time and, owing to prolonged intensive land use, have suffered from degradation by erosion, loss of organic matter, structural deterioration, and contamination from excess nitrates, agrochemicals, and salinity. Moreover, changes in agricultural practices as well as increases in urban development have intensified environmental problems and accentuated pressures on agricultural land and Malta's fragile semi-natural ecosystems. Similarly, water resources (both quantity and quality) in Malta are also under severe stress owing to socio-economic development, over-abstraction for agricultural irrigation and from diffuse pollution. This paper briefly explores the key soil and water challenges facing farmers and the agricultural sector in Malta. Selected technology based and management innovations to improve resource use efficiency, sustain productivity, and support the agricultural sector are identified and discussed. The evidence forms part of FOWARIM 'Fostering water-agriculture research and innovation in Malta', an EC H2020-funded twinning project that is building research capacity, supporting knowledge exchange to practitioners, and providing evidence to inform policies for government and the agricultural sector in Malta.

Keywords:

agriculture, soil, nutrient, irrigation, management, maps, water resources.

TOMATOE PRODUCTION (Solanum lycopersicu) UNDER SUBSURFACE DRIP IRRIGATION WITH TWO TYPES OF DRIP TAPES

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Due to the high acquisition costs of drip tape for subsuperficial irrigation (SDI), in some places of Mexico drip tape originally made for superficial irrigation (SUR) is been used for subsuperficial irrigation, replacing SDI drip tape. However, effects in production and emitter discharge uniformity, is unknown. The objective of this study was to compare the effect on yield and the emitter discharge uniformity coefficient in a tomato crop, of SDI and SUR tapes, both with same diameter and emitter flow, installed superficially and at the subsurface at different depths: 10, 15 and 20 centimeters. The experiment was realized in a greenhouse and the texture of the soil used for the planting was Sandy loam, in plastic containers. In the eight installed drip treatments nutrient solution and irrigation conditions were the same. Variance analysis made to the production results, with a significance level of α=0.05, didn't show statistically significand differences between the two tapes, neither in the installation depths. It was numerically observed a higher yield in the SUR tape, with a higher production with a deeper installation; on the other hand, in the SDI tape no defined tendency was observed in the four installation depths. The UC results were 99.1 and 96.6% for SDI and SUR, respectively, previous to the tape installation; after harvest the UC in both tapes were reduced, recording lower values in SDI tape and a UC decrement was observed in both tapes as the depth increased. Results suggest that it is possible to use SUR tape, evaluated for similar conditions to the ones used in the experiment of this investigation, at least for one production cycle, without affecting the crop's production and with a lower acquisition cost.

Keywords:

Fertigation, greenhouse, drip tapes, subsurface drip irrigation, surface drip irrigation, uniformity coefficient.

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Moringa (Moringa oleifera) produces edible, nutrient-dense leaves often utilized to alleviate malnutrition. A trial was conducted in southwest Florida, under subtropical conditions, to determine the extent to which leaf production can be maximized with fertility inputs. Moringa seeds were sown in the field on 24 March 2015, with trees spaced 1.25 m (in row) X 3.5 m (between row). The following year (9 June 2016), the trees were pruned to a height of 1 m and fertility treatments begun. With treatments replicated three times in a split block design, each of five trees per plot received 0 or 2 kg of composted yard waste (whole-plot factor), as well as the equivalent of 0, 25, 50, or 75 g of nitrogen (sub-plot factor) supplied with 8-2-8 (NPK) fertilizer. These treatments were split-applied with half of each NPK or compost rate applied six weeks apart. The first half of each split application was applied at three-month intervals that, with the exception of a winter rest period, corresponded to moringa leaf harvests. Dry leaf matter, weighed at each of six harvests (from September 2016 to November 2017), varied with NPK rate ($P = 0.0069$) and harvest ($P < 0.0001$). Regardless of whether or not the trees received compost, dry leaf yield (averaged over six harvests) increased linearly from 51 g tree-1 with no NPK to 108 g tree-1 with enough NPK fertilizer to supply 75 g N tree-1. Averaged across fertility treatments, leaf yields ranged from 38 g tree-1 at harvest 1 to 147 g tree-1 at harvest 2. Lowest yields coincided with a time of high rainfall and poor drainage. Results, discussed in light of soil and leaf nutrient concentration data, show that fertilization of sandy soil can markedly increase moringa production.

Keywords:

moringa, Moringa oleifera, fertilizer, input, amendment, leaf yield, dry matter

Effects of alternate partial root-zone drip irrigation on tomato growth and yield were modulated by the allowable soil water depletion

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Alternate partial root-zone drip irrigation (APRDI) is more efficient in saving irrigation water than conventional drip irrigation (CDI), and has attracted intensive attentions worldwide recently. However, to date the time of alteration of the irrigation from the wet to the dry side has done mostly empirically. In this paper, the effects of APRDI on tomato growth and fruit quality at different allowable soil water depletion (AWD) were investigated. The experiment was conducted in a greenhouse with three experimental factors: irrigation method (including CDI, APRDI, coded as “C” or “A”, respectively), irrigation level (sufficient or deficient irrigation, coded as “S” or “D” , respectively), and AWDs (80%,70%,60% of the field capacity), resulting in 8 treatments CS80,AS80,AS70,AS60, CD80,AD80,AD70,AD60. In deficient irrigation, 65% of the water consumed in sufficient irrigation treatment was applied. The results showed that, there is no significant difference in shoot biomass among the treatments with sufficient irrigation, whereas the fruit yield of AS70 increased by 6.52% compared with CS80. Reducing the irrigation water decreased shoot biomass and fruit yield significantly. The biomass of AD70 and AD60 decreased compared with that of CD80. Fruit yield of AD80, AD70 increased by 8.58%, 17.41%, respectively, whereas AD60 had no significant difference in yield compared with CD80. Fruit quality was improved when irrigation amount decreased. Compared with the treatments with ILL at 80%, APRDI with ILL at 70%, 60% improved fruit quality in terms of reducing sugar, total soluble solids, soluble sugar, Vc content, and the sugar/acid ratio. Thus, APRDI with AWD at 70% is a better choice for tomato production, which could improve fruit quality and yield, especially under low irrigation level.

Keywords:

Alternate partial root-zone drip irrigation, allowable soil water depletion, field capacity, irrigation level, yield, quality

Changes in Fruit Quality, Water Applications, and Mineral Nutrients as Impacted by Various Irrigation Systems and Canopy Maturity in `Fuji´ Apples

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Over the span of 10 years, the impact of several irrigation systems, scheduled based on crop evapotranspiration, a crop coefficient value, ground shading, and tree canopy maturity provided a reliable tool for irrigation of ‘Fuji’ apples. Trees with a full sprinkler (FS) received 72% more water

when they were young and received about 40% more water when they were completely mature than those with a full drip (FD) during the period of 2002 and 2011. Young trees received 5617 L water/tree in FS and 2921 L/tree in FD system. However, mature trees with a FS received 5928 L (944 mm), while those with a FD received 3610 L of water per tree (554.9 mm) per growing season. Deficit irrigation increased fruit initiation in young trees but reduced yield in mature trees. Fruit from trees with FS and FD were larger, while those with 50%FS were smaller than those from other treatments in both young and fully mature trees. Mature trees with 50%FS received a higher volume of water but had smaller fruit size than those with 50% full drip (50%FD) or 65% full drip (65%FD). Applications of any form of deficit irrigation, either by sprinkler or drip, increased fruit soluble solids concentration and firmness but decreased water core at harvest in mature trees. If application of deficit water is mandated, the use of 65%FD is preferred over 50%FS, as trees with a 65%FD treatment received less water while had larger fruit than those of 50%FS. Trees receiving 80 g N/tree had lower fruit color and russet than those receiving 40 g N/tree. Leaves from trees with FS and FD had higher K. Yield was lower but fruit size was larger during the first 4-year cycle than those in the second 4-year cycle of tree growth in all treatments.

Keywords:

fruit quality, irrigation efficiency, long-term irrigation study

Fast and non-destructive method for estimating grapevine water status

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Appropriate water management assessment methods in vineyards are critical for modern precision viticulture (PV) practices. In this context, traditional methods used for measuring water status in grapevines are costly and time-consuming. The main objective of this study was to estimate grapevine water status using a fast and non-destructive method. The study focused on the potential of using a handheld spectroscopy sensor for fast and accurate estimation of leaf water potential (LWP). The experiment was conducted at Welgevallen experiment farm of the Department of the Stellenbosch University in a vineyard block cv. Pinotage. Sampling points (n=33) were selected considering the different water conditions presented in the experimental block. LWP and spectral

data were measured at midday simultaneously in each sampling point using a digital Scholander pressure chamber and a handheld fluorescence detector fitted with a 405 nm laser excitation source and a USB spectrometer (OceanOptics) with a wavelength response from 200 to 900 nm. The data analysis was carried out using a customised Matlab (R) code and the PLS-Toolbox. A variable selection method with the VIP (variable importance in projection) criteria was used to develop the Partial Least Square (PLS) regression model. Results show a high correlation between the measured LWP and the LWP estimated by the PLS model with a coefficient of determination (r2) in the cross validation of 0.86. The error in the model was low with a Root Mean Square Error of Cross Validation (RMSECV) of only 0.45 Bars. These results show the potential of this method for a fast and non-destructive determination of grapevine water status under field conditions as a tool for decisions making during irrigation scheduling.

Keywords:

PLS regression; modelling; precision viticulture; spectroscopy; variable importance in projection.

Availability of water resources for tomato production in Colombia: a basic modelling approach

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Colombia is one of the most water abundant countries in the world; nevertheless, the availability of this resource is limited in some agricultural regions. As horticulture is recognized as a highly water demanding sector, this work aims to determine the monthly water supply and demand of the open field (OF) and greenhouse (GH) tomato production systems, established in contrasting catchments. The OF production area corresponded to the Fonce river basin which is the main stream of the Guanentá province (6º25'18.83''N, 73º10'03.18''W; 1370 masl). The selected GH tomato production area is located in the Moniquirá river basin in the Alto Ricaurte province (5º39'37.30''N, 73º34'57.46''W; 2070 masl). The estimated tomato production areas were 320 hectares for OF and 330 hectares for GH production area. We used the soil and water assessment (SWAT) hydrological

model to estimate the water supply. Required soil and weather inputs for SWAT simulations were obtained from the geological and meteorological Colombian services, respectively. Tomato water demands were determined by a series of successive growers' pilot studies at farm level. Results showed that the water supply is higher in the OF area (1.49 Mm3 km-2 yr-1) as compared to the GH (0.37 Mm3 km-2 yr-1). Water supply follows the same bimodal distribution trend as the rainfall throughout the year. During the dry season, water supply for OF and GH areas is only around 21 and 4%, respectively, from that of the rainy season. GH systems have the highest water demand (2.83 Mm3 yr-1), while OF demand 0.78 Mm3 yr-1. For the OF system most plantings are synchronized with the first rainy season while GH production is continuous throughout the year. El Niño-southern oscillation have highlighted the susceptibility of the GH tomato system to water scarcity.

Keywords:

water scarcity, SWAT model, greenhouse tomato

Evapotranspiration and Crop Coefficients of Pistachio (Pistacia vera L.) Orchards Grown on Saline Soils with Micro-irrigation

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In California pistachio acreage is rapidly expanding on salt-affected areas due to its economic profitability and salt tolerance. However, no information is currently available to growers on the actual water use of mature pistachio orchards grown with micro-irrigation on soils with high salinity. We conducted a multidisciplinary field study during the 2016 and 2017 crop seasons to determine the actual evapotranspiration (ETa) and crop coefficient (Ka) trends of two well-watered commercial pistachio orchards (Kerman variety onto PGI rootstock) grown with micro-irrigation on soils with variable degrees of salinity in the San Joaquin Valley (CA). A well-managed non-salt affected orchard located in the same area was also monitored and considered as control study orchard. We used the residual of energy balance method with a combination of eddy covariance and surface renewal equipment to measure the sensible heat flux density. In order to characterize the effect of salinity on tree canopy size and tree water status we measured the percentage of photosynthetically active radiation intercepted by the tree canopy (fPAR) and midday stem water potential (Ψstem). Salinity strongly affected tree canopy size. The non-salt affected orchard intercepted 75% of incoming PAR while under salinity the radiation interception was significantly lower (66, 50, 35 and 25%). The relative contribution of sensible heat flux to ETa increased to a maximum of 18% in the most salt impacted sites. ETa was 10 to 30% lower in the salt affected orchards relative to the control orchard. The Ψstem values in the non-salt affected orchards were consistently above -1.5 MPa along the crop season, whereas values of Ψstem as low as -3.0 MPa were observed in the salt affected orchards. The Kc under salinity was 0.40 in April, between 0.60 and 0.80 from May to mid-July, and decreased to around 0.25 in October. The electro conductivity of the soil saturated paste extract (ECe) did not explain the differences in ETa and fPAR among sites, suggesting that the secondary effect of sodicity on soil physical properties, causing compaction and reduced aeration, may have a strong effect on pistachio performance. Irrigation water volumes currently applied by commercial growers to salt affected orchards are around 33% higher than the measured seasonal ET values. This over application of water not only decreases irrigation efficiency but may also harm the tree health as a consequence of reduced infiltration and waterlogging due to sodicity and poor soil structure. Our results highlight the necessity to better understand the long term response of pistachio water use and water applications in salt affected soils with the aim of improving water management and orchard performance in pistachio.

Keywords:

Eddy Covariance, Surface Renewal, Water Use, Canopy Cover, Salinity

Actual Evapotranspiration and Crop Coefficients for Mature Pistachio Orchard Grown with Micro-Irrigation in the San Joaquin Valley of California

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The most used crop coefficient (Kc) values available for irrigation scheduling of pistachio in California were developed in study conducted during the mid '80s in a sprinkler-irrigated orchard of Kerman cultivar grafted onto P. Atlantica rootstock. Presently, the majority of pistachio orchards are grown with micro-irrigation, which increases irrigation efficiency and water productivity, while reducing the evaporative water losses. In 2015-2017 we conducted a three-year field study to estimate the actual evapotranspiration (ETa) of a well-watered, mature (30-year old, 75% canopy cover) commercial pistachio orchard (Kerman variety onto PGI rootstock) grown on a sandy-clay-loam soil with drip irrigation in the San Joaquin Valley of California. Our main goal was to update the information of actual water use of pistachio orchards with the current orchard management practices and features. To estimate the actual orchard's water use, we used the residual of energy balance method with a combination of eddy covariance and surface renewal equipment to measure the sensible heat flux density. Results confirm the ability of pistachio to uptake and use large water volumes when fully irrigated, resulting in an average ETa of 7.5 mm day-1 during the hottest months (June and July) and a peak daily water use reaching up to 10 mm in late June. The highest Kc values reached 0.90 during the period from mid-May to mid-July. Kc was 0.80 from mid-April to mid-May and during August. In September, a steep decrease of Kc was observed, reaching values around 0.50, most likely as a result of growers reducing water application before harvest. The Kc values documented with the earlier study conducted during the '80s ranged from 0.43 at the end of April to 1.19 in mid-July and decreased to 0.67 in October. The newly-developed water use information could enable pistachio growers to conduct more precise irrigation management and better tailor irrigation to actual orchard water needs along the crop season. Higher water productivity and improved resource efficiency could be achieved by pistachio growers with the adoption of updated Kc values developed in this study within the normal irrigation scheduling practices.

Keywords:

Water Efficiency, Water Use, Eddy Covariance, Surface Renewal

INITIAL DEVELOPMENT OF PUMPKIN IN THE PRESENCE OF BIOLOGICAL AGENTS

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The pumpkin crops is very cultivated and consumed in Brazil. The aim this work is to verify the initial development of pumpkin plants cultivated on substrates with and without a presence of biological agents. The experiment was conducted in protected cultivation at the Southwest Bahia State University, Brazil, in period of 10/16/2017 (planting) on 10/11/2017 (evaluation). The design was a completely randomized design with three replicates, in a 2x4 factorial, comprising two substrates, in the presence and absence of two biological agents as soil conditioners (Trichoderma longibrachiatum, Trichoderma harzianum) and humic and fúvic acid as positive control and absence of biological agents as negative control, as seeds were planted in pots (15x28x08 cm), each repetition consisted of five pots, totaling 120 pots. Samples were collected from the substrates for initial analysis and at the moment of the evaluation in order to compare their results. In relation to plants as evaluated the following characteristics: Chlorophyll "a", "b" and total; branch length (cm); lap diameter (mm); root length (cm); fresh weight of shoot and root (g); number of leaves and dry weight of shoot and root (g). At end of the evaluations was observed with the soil with manure presented the significant difference for the characteristics of the branch; lap diameter; root length; fresh and dry weight of shoot and root, and the biological agents and as interactions did not present significant difference in the emissions of notes.

Keywords:

Cucurbita maxima, Trichoderma sp., soil conditioners.

TOMATO CULTIVATED WITH BIO-STIMULATING AND ORGANOMINERAL FERTILIZATION

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Tomato cultivation demands high financial values, as well as manual or mechanized labor, as well as high-tech inputs such as biostimulants and organomineral fertilizers. In the Brazilian trade there are several brands and formulations of vegetable biostimulants, being necessary to investigate the efficiency in agricultural production. The objective of this work is to evaluate the use of different biostimulants in tomato cultivation under organomineral fertilization. The experiment was conducted in commercial tomato growing in Mucugê-BA from November 2016 to March 2017, treatments consisted of the use of 2 different biostimulants: T1- Raiz® + MOL Top®; T2- Complex GZA®; T3- Complex GZA® + 500 kg of additional forms 02-26-02 organomineral Basiduo® in the heap, distributed in randomized blocks with seven repetitions. All the treatments received in the planting groove 1500 kg of Basiduo + 500 kg in the heap and the T3 referring 500 kg more of the fertilizer in the heap. At 110 days after the evaluated planting and dry mass of root and shoot, SPAD index, fruit dry mass, export of macronutrients (N, P, K, Ca, Mg and S), number of fruits and productivity. There was no difference in dry mass of root, shoot and SPAD index. For dry mass of the fruits of treatment 3 presented a higher deferred content statistically of the others. Macronutrients N, P, K and S presented as major exporters, with the exception of O that is exported in greater quantity by treatment 1 without statistically differing from treatment 3, for the number of fruits and productivity, greater increase observed in treatments where used the biostimulant GZA®, and the treatment that led to an increase of 500 kg organomineral in the heap showed a greater gain in productivity.

Keywords:

Solanum licopersycum, growth promotion, organic fertilization.

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Infrared thermography has been used to assess plant transpiration and infer stress levels in different agricultural applications. However, the cost of this technology has previously been prohibitively high and its use requires training, hence the technology has not been widely adopted by growers. The development of low cost infrared cameras adapted to smart phones provides an opportunity to develop smart phone applications that would allow growers to monitor crop water status. We explored the capabilities of this system in an experiment using different irrigation targets according to the crop water stress index (CWSI), which is based on measuring leaf (and wet and dry reference) temperatures. Soya bean plants were grown in pots in a glasshouse and divided into three treatments. Treatments were applied for two weeks. Well-watered plants (WW) were watered according to pot weight to replace the daily evapotranspiration. Well-watered with thermal

scheduling (TSWW) and deficit irrigation with thermal scheduling (TSDI) were watered only when CWSI was above a threshold value with 100% or 50% of the accumulated average amount of water applied to WW plants respectively. Statistical differences in CWSI between WW plants and those from which water as withheld started to appear when CWSI of the stressed plants was around 0.5, which was the irrigation threshold for TSWW and TSDI plants CWSI and stomatal conductance were strongly correlated (r2 = 0.72), even among well-watered plants and across the two weeks of irrigation treatment application. Treatment biomass varied with irrigation volume, with TSWW having similar biomass as WW plants. Thus, the accuracy of this affordable system to measure leaf temperature is good enough to provide a reliable estimate of plant water status, which can be used in irrigation scheduling.

Keywords:

thermal imaging, stomatal conductance, irrigation scheduling

Irrigation scheduling in a high density olive orchard from estimated stomatal conductance

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Achieving more resilient agricultural systems through regulated deficit irrigation (RDI) could contribute to ensure food production with less water than other irrigation strategies. However, the management of RDI needs a reliable and sensitive indicator of water stress. Stomatal conductance (gs) is a good plant-based indicator, because it reflects finely the level of water stress and photosynthesis limitations. We conducted an experiment to schedule a RDI strategy for super high density olive orchards, from modelled gs (summer 2017, Spain). We had three treatments with four replicate plots each: two control treatments, one of them irrigated with the Kc method (100CKc) and the other one from the estimation of gs as a function of vapor pressure deficit and radiation (100Cgs). We also had one RDI treatment (45RDI), in which 45% only of the water supplied to the 100Cgs treatment was applied. Stomatal conductance modelled for 100Cgs was compared to gs estimated using sap flow measurements. We found a good agreement between gs estimated with the two methods (R2=0.9, pgs (3722.6 m3 ha-1) was lower than in 100CKc (4103.2 m3 ha-1), with no effect (p>0.05) either on the trees water status (average predawn leaf water potential was -0.67 MPa in 100Cgs) or in fruit yield (12633.0±3447.9 and 13290.1±1256.4 kg ha-1 in 100Cgs and 100CKc, respectively). Yield in 45RDI was significantly reduced (7398.7±276.1 kg ha-1) as it was the estimated gs, which decreased around 30% respect to 100Cgs. We conclude that it is possible to schedule irrigation in olive from automated estimations of gs. This opens the possibility for determining targeted levels of stress as a function of gs.

Keywords:

regulated deficit irrigation; fruit yield; virgin olive oil

Effect of plug production on the growth of rhubarb(rheum rhabarbarum) by open field

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plug seedling technology is needed to produce a uniform young seedling of rhubarb(rheum rhabarbarum). when plug production rhubarb, the size of the plug and the length of seedlings were examined. production rhubarb, the larger the plug size, the larger the tomb and the more leaves. seedlings during 40days which is seeded in 162 plug tray was effective in seedling quality and mat formation. based on 40 days of seedling period, the plug standard was the best at 162 pulg. rhubarb root formation was superior to 128 pulg, and 162 pulg.

Keywords:

rhubarb,plug seedling

Effect of pre-harvest foliar calcium application on fruit quality in Gold3 kiwifruit

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The current nutrient management practices for gold kiwifruit (Actinidia chinensis Planch. var. chinensis 'Zesy002', commonly known as Gold3) need to be optimized to improve fruit quality. The fruit quality of kiwifruit is mainly affected by low fruit calcium (Ca) content. There are many pre-harvest reasons for low fruit Ca content, including, but not limited to, low Ca uptake by the roots and translocation to the fruit (at late fruit developmental stage) even in Ca enriched soils. This study was aimed to optimize fruit nutritional and other quality characteristics. The study was based on the hypothesis that pre-harvest foliar Ca application may increase fruit Ca content and improve fruit quality. Different formulations of Ca such as CaCl2 and a commercial product Calbit, at the application rate of 1 % Ca w/v, were used. All the treatments were buffered to adjust pH 5.5 and applied five times at weekly interval at late fruit developmental stage. After thirty-day storage at 0° C, the results indicated that CaCl2 and Calbit highly significantly (PPP2 compared to control. While fruit dry matter content was non-significantly increased by 3 % and 7 % due to CaCl2 and Calbit compared to control. It was concluded that foliar Ca application was beneficial to increase fruit Ca content and other fruit quality characteristics.

Keywords:

Key Words: SunGold, nutrient management, fruit Ca content, limited Ca uptake, at harvest, storage