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OPENNING AND CLOSING LECTURES
Nutritional research over the past 30 yrs in the irrigated tree fruit growing region of the Pacific Northwest of North America has emphasized the development of strategies to overcome soil and plant limitations resulting in nutrient deficiencies of P, K and Ca and toxicities of B, As and Mn. Improved nutrient use efficiency has been sought for this irrigated region by development of fertigation strategies for the macronutrients N, P and K in an effort to more closely match nutrient application to plant demand. Nitrogen research has been particularly emphasized due to the mobility of N in the environment and its ability to be remobilized within the plant. At the same time, more precisely targeted foliar nutrition strategies have been developed for key micronutrients and for Ca, the nutrient most closely associated with improved fruit quality.

Future scientific and social trends are likely to affect the conduct of nutritional research over the next 30 yrs. Key issues will be examined from this viewpoint. These issues include the implications of high energy costs, possible consequences of climate change, the potential development of precision horticulture, and low input, integrated and organic production systems, increased emphasis on maintenance of soil health and quality as well as our ability to integrate ecophysiological and molecular approaches into our research.
Sustainable plant nutrition faces a number of challenges of several natures: ecological, economic, practical and political. Strong demand for agricultural products is likely to persist for the foreseeable future. This is promising for the economic prospects of the fertilizer industry, but makes it all the more imperative to increase nutrient use efficiency. Unless greater efficiency becomes the norm, unwanted impacts related to nutrient losses will only intensify as nutrient use further expands. At the same time, the fertilizer industry’s capacity to meet the demand for fertilizers is stretched, because previous low fertilizer prices led to underinvestment in the development of new production capacity. There is also the matter of making the most of limited mineral resources. In this context, the development and widespread adoption of site-specific fertilizer best management practices is more important than ever.

Yet there are many gaps that remain in our knowledge and understanding about crop nutrition, and resources are scarce for the extension activities that help farmers implement existing good practices. It is essential to improve the development and deployment of additional innovations in crop nutrition. As well as further research, this implies the need for institutional and financial support from policy makers. It is also critical that communication efforts be intensified to help decision makers and the general public to understand the stakes involved.
SESSION 01
WATER SAVING AND MINERAL NUTRITION
DEFICIT IRRIGATION PRACTICES
SAVING WATER WITHOUT REDUCING FRUIT
YIELD AND QUALITY?

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Water is a scarce resource worldwide and most climate change scenarios suggest that an increase in aridity will take place in many areas of the globe, placing huge constraints on plant growth. Understanding how plants respond to drought and co-occurring stresses is of utmost importance to overcome these constraints and improve resource plant efficiency. On the other hand, irrigated agriculture remains one of the largest and most inefficient users of water resources. Low water use efficiency (WUE) together with an increased competition for water resources with other sectors (e.g. tourism or industry) are forcing growers to adopt new irrigation and cultivation practices that use water more judiciously. In areas with dry and hot climates, drip irrigation and protected cultivation have improved WUE mainly by reducing runoff and evapotranspiration losses. However, complementary approaches, aiming at decreasing water consumption for similar carbon assimilation, are still needed to increase WUE in irrigated agriculture. Deficit irrigation strategies like regulated deficit irrigation or partial root drying emerged as potential ways to increase water savings in agriculture by allowing crops to withstand mild water stress with no or only marginal decreases of yield and quality. How plants respond to mild water deficits, namely as a result of short and long distance chemical and hydraulic signals, and how whole plant acclimation to this limited resource takes place will be discussed. The interplay between water and nutrient use efficiency by the plants will also be highlighted.
EFFECT OF CROP LOAD AND IRRIGATION MANAGEMENT ON FRUIT NUTRITION AND QUALITY FOR AMBROSIA/M.9 APPLE

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The size of the reproductive sink affects the amount of C and N allocated to fruit in apple trees, but less information is available for other nutrients. Deficit irrigation practices have been advocated as methods for controlling vegetative growth, improving fruit quality and reducing water use. We examined the effects of restricting soil moisture and the size of the root zone on differential uptake and partitioning of nutrients under conditions where high crop load may increase susceptibility to water stress. Ambrosia/M.9 apple trees were planted in 2003 on a sandy loam soil, in a split plot experiment with a randomized complete block design, replicated six times. Each tree received drip irrigation from two 4 l.h⁻¹ emitters, located at 30cm perpendicular to the row. In 2006, four irrigation treatments were randomized to the main plot units: 100% daily ET replacement applied to both sides of the tree; 50% ET to both sides of the tree; 50% daily ET replacement to one side of the tree; 50% applied to both side of the tree every second day. In 2007, the same irrigation treatments were applied with the one-sided treatment switched to the opposite side. Different levels of reproductive effort were established in the sub-plot units by thinning fruit to crop loads of 10, 5 and 2.5 fruit per cm² trunk cross sectional area. The interactive effects of the amount and spatial configuration of water supply and the level of reproductive effort on fruit quality and nutrient allocation to fruit will be discussed.

Keywords: allocation, drip irrigation, fruit size, water deficit
Deficit irrigation may be used to control canopy development, yield, and fruit composition in order to enhance fruit color, texture, and juice composition. The present study was carried out in 2007 using five-years old Lambrusco grapevines grown with the root system split into four pots. Water stress was applied on half of the vines (stressed) by withholding water from three out of the four pots from pre-veraison till harvest. Mineral concentrations were measured on leaves collected at harvest. At harvest, yield and cluster number per vine were recorded. Samples of 200-berry were collected in order to obtain qualitative parameters (°Brix, titratable acidity, pH, malic acid, tartaric acid, potassium, and total anthocyanins and phenolics) and to investigate mechanical properties (berry elasticity, berry skin hardness, and berry skin thickness) using a TAxT2i Texture Analyzer. Mineral content of samples of berries was also recorded at harvest time.

Yield of control vines was higher than stressed ones; sugar concentration, acidity and pH were similar between treatments, while malic acid and potassium of control vines were higher than stressed ones. Mechanical properties of berries were strongly affected by water stress, showing a significant increase of berry skin weight (+16.6%) and a decrease of elasticity (-22.4%). Ca, Mg, and B content in leaves and in berries significantly changed when water stress conditions were imposed. Also S, and Mn content in leaves and P content in berries were affected by treatment. As plant nutrient availability depends on water flow through the soil-root-shoot pathway, nutrient uptake by grapevines and different flows of nutrients from leaves to berries during water stress conditions were recorded. In particular low Ca and high Ca levels in leaves and berries were respectively registered in stressed vines indicating an important role of Ca in enhancing berry skin thickness. The same flow from leaves to berries was noticed for Mg. For B, instead, low levels were found as in leaves as in berries of stressed plants.

**Keywords:** berry skin thickness, nutrient’s flow, texture analysis
EFFECT OF NUTRIENT AND WATER MANAGEMENT ON NUTRITION AND GROWTH OF YOUNG ‘CRISTALINA’ AND ‘SKEENA’ SWEET CHERRY ON GISELA 6 ROOTSTOCK

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High density plantings of sweet cherry on dwarfing rootstocks are of interest due to the potential for more rapidly achieving high unit area yields. To achieve this aim, initial establishment and growth will need to be optimized. A field trial was planted in spring 2005 to assess the effects of mulching, irrigation frequency and P-fertigation on initial growth, yield and nutrition of ‘Cristalina’ and ‘Skeena’ sweet cherry cultivars on Gi. 6 rootstock. The experimental design involved 6 replicated main plots of two irrigation frequencies with the same amount of water applied either at high (4 x per day) or low frequency (once every 2 days). Subplots comprised the two cultivars containing 2 tree plots subjected to management treatments involving either in-row mulching, fertigation of 20 g P/tree at bloom or neither treatment (control).

Irrigation frequency had the greatest effect on sweet cherry performance in the first two growing seasons. Soil moisture measurements to 20 cm depth indicated consistently higher soil moisture contents just prior to irrigation throughout the growing season for high frequency irrigation. Leaf stomatal conductance was increased during the hot, dry July-August time period, trees were larger after two years and K and B nutrition were most improved. Mulching increased stomatal conductance and together with P-application increased tree vigor and leaf P concentration when receiving high frequency irrigation. ‘Skeena’ and ‘Cristalina’ generally responded similarly to treatments but ‘Skeena’ maintained higher leaf stomatal conductance values and were larger than ‘Cristalina’ by the end of year two.
SPATIAL DISTRIBUTION OF IRRIGATION AND PRODUCTIVITY OF THE PEAR CULTIVAR ‘ROCHA’

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The effect of spatial distribution of irrigation water was studied in an orchard of pear cultivar ‘Rocha’ located at Peral (Cadaval, Portugal). The three applied drip irrigation treatments were: (1) one irrigation line in each row of trees with a debit of 4 L.h⁻¹; (2) two lines per row 0.5 m apart from the trees, each dispensing 2 L.h⁻¹; and (3) two lines per row distant 0.5 m from the trees, each dispensing 4 L.h⁻¹ every other week out of phase with the other line. The total amount of water and fertilizers were the same in the three treatments. For each treatment, 150 trees were used (in three rows of 50) from which 30 fruits were randomly selected and labelled at fruit set and their bigger diameter was measured at weekly intervals. Results were consistent during three years of observation, showing that productivity per tree was highest with two irrigation pipes at 2 L.h⁻¹, followed by two lines dispensing water and nutrients in alternate weeks. The same trend was observed on fruit size. Firmness and total soluble solids at harvest did not show significant differences. The kinetics of fruit growth were significantly different in the three groups, as evaluated by fitting their cubed diameters to the autocatalytic equation. It is concluded that distribution of water and fertigation in a larger surface area (and a corresponding larger volume of soil) results in a better utilization of the applied nutrients and as a consequence reduces the environmental stress due to their leakage.
THE INFLUENCE OF PLANT CO-CULTURE WITH PIRIFORMOSPORA INDICA ON PLANT BIOMASS ACCUMULATION AND STRESS TOLERANCE

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Piriformospora indica is a recently discovered (Varma et al 1999) arbuscular mycorrhiza-like fungus, which can be cultured, in vitro and has a broad range of plant interactions. Reports of plant growth promotion associated with Piriformospora indica are known and well studied for several plant species and under several environments. However the promotion of plant growth can be associated with higher efficiencies of nutrient use for biomass production or increased efficiency in nutrient acquisition. The aim of our work was to make a survey of the effects of the association of Piriformospora indica with several plant species: Ceratonia siliqua, Quercus suber, Acacia longifolia, Sorghum bicolor; and Solanum lycopersicum. The effects of the co-culture were assessed on the first stages of plant development under stress and no-stress conditions (Watering stress: control (40-60%) and 10-20% field capacity, salt stress: control and 1.75% NaCl (40-60% field capacity); nutrient stress: control and ¼ Hooghard solution (40-60% field capacity). Several parameters: biomass accumulation; mycorrhizal colonization; soil microbial community; plant isotopic composition for C and N; and mineral composition of biomass were used in the assessment of the effect of the co-culture of Piriformospora indica with each plant species.

The results obtained so far indicate that the positive effects of the co-culture are highlighted by several parameters, mainly when plants are cultured under stress conditions. Results will be interpreted on an ecological and agronomical perspective.
DISTRIBUTION OF APPLE ROOTS INFLUENCED BY MOISTURE REGIME MANAGEMENT AND POTASSIUM IN SOIL

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The aim of this research is to clarify root distribution of apple trees on dwarf rootstock B 9 depending of soil moisture regime management and potassium concentration in the soil. This research may give to us a possibility to revise the recommendations for apple nutrition on vegetatively propagated rootstocks in the conditions of Latvia. There has been no such previous research. Only in the last decade of years the area of orchards with apple trees on dwarf and semi-dwarf rootstocks has increased. The investigation was done on the base of an existing trial planted in 1997 with cultivar ´Melba´ on rootstock B 9, 1.5 x 4 m distance, Latvia State Institute of Fruit-growing, Dobele, Latvia. In the strips the trial had such soil management variants: control, sawdust mulch and fertigation. For characterizing of root distribution, trenches were dug near the trees perpendicular to the row of trees, 1.2 m deep, 2.6 m long and 0.8 m wide. The roots differed by size were counted using a frame with 0.15 x 0.15 m pixels. Also soil samples were taken from soil profiles using frame with 0.3 x 0.3 m pixels at two depths. In this paper we analyze only the influence of potassium concentration (DL method). The first findings showed that the root distribution of apple trees on depended of soil moisture management in this trial. Also they have some dependency on the potassium concentration in soil.

Keywords: fertigation, Malus, potassium, root distribution, soil moisture
IRRIGATION AND NITROGEN FERTILIZATION EFFECTS ON GROWTH, YIELD AND FRUIT QUALITY PARAMETERS IN PEACHES FOR PROCESSING

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Peach production in semi-arid regions depends on key factors like water availability and nutrient application to obtain good yields and high fruit quality. The objective of the present study is to know the effect of different irrigation strategies and nitrogen doses on plant and fruit growth, yield and quality on peaches for processing.

The experimental plot was established in 2006 in a commercial orchard in the north-est of Spain, in Torres de Segre (Lleida). Six-year-old Andross trees on GF 305, unthinned, and trained on a free palmette in a shallow soil were used. Three irrigation treatments were evaluated according to fruit growth stages: 100% full ETc during all the season, 30% ETc during stage II and 70% ETc during stage III, combined with three nitrogen fertilization treatments: 0, 60 and 120 kg N/ha. Trees were mechanically harvested with a continuum trunk shaker.

The amount of water saved throughout irrigation reduction either in stage II or stage III of fruit growing accounted for 12% of total water applied. Deficit irrigation during stage II did not affect fruit quality but vegetative growth decreased and foliar nutrient relationships were altered. On the other hand, deficit irrigation during stage III supposed a reduction in final fruit size and yield and it was observed an increase in fruit firmness and total soluble solids during that period.

When no N was applied, fruit growing season decreased: ripeness was enhanced, firmness was reduced and red fruit flesh colour increased. N fertilization increased leaf and fruit N concentration but any yield response was obtained.

The experiment is on-going and will continue during the 2008 growing season.

Keywords: fertigation, N concentration, Prunus persica, RDI
EFFECTS OF METHOD AND LEVEL OF NITROGEN FERTILIZER APPLICATION ON SOIL pH, ELECTRICAL CONDUCTIVITY, AND AVAILABILITY OF AMMONIUM AND NITRATE IONS IN BLUEBERRY

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Blueberry (Vaccinium corymbosum L.) requires low soil pH and nitrogen primarily in the ammonium form for optimum growth. Nitrogen fertilizer methods and rates were evaluated in a new 0.6-acre field of ‘Bluecrop’ blueberry. Treatments included four application methods (split fertigation, continuous fertigation, and two non-fertigated controls) and four rates of N application (0, 50, 100, and 150 kg/ha N). Fertigation treatments were irrigated by drip and injected with liquid urea fertilizer; split fertigation was applied as a triple split from April to June while continuous fertigation was applied weekly from leaf emergence to 60 d prior to the end of the season. Non-fertigated controls were fertilized with granular ammonium sulfate and irrigated by drip or microsprays. In general, soil pH was lower with microsprays than with drip. Clearly, the effect of microsprays on soil pH was an effect of irrigation method and not the method of N application, as pH was lower with microsprays even when no N was added. However, soil pH was also reduced with higher N applications and was, in fact, similar between continuous fertigation and granular fertilizer (microspray) treatments when 150 kg/ha N was applied. Nitrogen application with granular fertilizer maintained much higher NH₄⁺ concentrations than continuous fertigation. However, electrical conductivity was often >2 mS cm⁻¹ when granular fertilizer was applied but always <1.5 mS cm⁻¹ with continuous fertigation. Nitrate ion (NO₃⁻) concentrations were also higher with granular fertilizer application than with continuous fertigation, but the ability of blueberry to acquire NO₃⁻-N is uncertain.

Keywords: ammonium-nitrogen, electrical conductivity, nitrate-nitrogen, soil pH
A TWO YEAR EXPERIMENT ON WATER SAVING IRRIGATION MANAGEMENT, PARTIAL ROOTZONE DRYING, RELATIVE DEFICIT IRRIGATION AND SUSTAINED STRESS IRRIGATION, ON CANNONAU GRAPEVINE IN SARDINIA (ITALY)

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The paper shows result of a two years experiment (2006 and 2007) on a native grapevine (Cannonau), irrigated according different irrigation strategies: Partial Rootzone Drying (PRD), Relative Deficit Irrigation (RDI) and Sustained Stress Irrigation (SSI) in an experimental fields characterized by sub surfaces irrigation system. The demonstrative trial wanted to relieve the productive capacity of Cannonau irrigated with different irrigation strategy in one of its typical lands (Nurra). The parameters relieved were: water requirements, quality and quantity productions, clusters biometry and plants fenology, pruning wood, soil water content, maximum daily shrinkage (MDS) and midday stem water potential (mSWP). Results of both years (2006 and 2007) shows that moderate or severe irrigation water reductions don’t induce a sensitive improvement on quality grape parameters in comparison with the well watered treatment. The most productive treatment was the RDI treatment and the most reducing was the Partial Rootzone Drying on the contrary to the expected result that put in evidence the CV Cannonau characteristic water stress avoidance behaviour. The water saving irrigation treatments (50% ETM RDI) induces an improvement on quality against the well watered treatment (100% ETM). Both water stress indicators (mSWP and MDS) gave an accurate differentiation between irrigation treatments.
A TWO YEAR EXPERIMENT ON WATER SAVING IRRIGATION MANAGEMENT, PARTIAL ROOTZONE DRYING, RELATIVE DEFICIT IRRIGATION AND SUSTAINED STRESS IRRIGATION, ON VERMENTINO GRAPEVINE IN SARDINIA (ITALY)

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The paper shows result of a two years demonstrative trial (2006 and 2007) on a native grapevine (Vermentino), irrigated according different irrigation strategies: well watered, Partial Rootzone Drying (PRD), Relative Deficit Irrigation (RDI), Sustained Stress Irrigation (SSI) and the on farm irrigation management, in a vineyard characterized by sub surfaces irrigation system. The trial wanted to prove and relieve the productive capacity of Vermentino grapevine irrigated with different irrigation treatments in its own typical lands (Gallura). Parameters relieved were: the water requirements with a computerized automatic system, the quality and the quantity of production, the clusters biometry and the plants fenology, the pruning wood, the soil water content, the maximum daily shrinkage (MDS) and the midday stem water potential (mSWP) as main fisiological parameters. Results of both years (2006 and 2007) shows that moderate irrigation water reductions induce an improvement on most of quality grape parameters without the awaited reduction on productivity as the RDI treatment and in particular the PRD. Severe water reductions as the on farm water management as well the SSI induce a sensitive grape production reduction both years. The MDS was a more usable parameter than the midday SWP to reliefe on Vermentino grapevine difference water stress level induced by those irrigation treatments.
ALleviation of salt stress using exogenous proline on citrus cell line

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The addition of the amino-acid proline to a Citrus sinensis cv. ‘Valencia late’ cell culture, a salt sensitive line, exposed to salt conditions, was evaluated in terms on the cell metabolism. Salinity constitutes an important abiotic problem since ancient time, world-wide, what leads to a decrease in productivity of crops with agronomic value. Under salt stress conditions, plant cells develop strategies to cope with, Na⁺ and Cl⁻ exclusion and compartmentalisation, induction of antioxidant enzymatic system and compatible solutes accumulation. Generally, proline is one of these compatible solutes exhaustively studied. The precise function of this osmolyte still remains unclear. Proline may act on osmotic adjustment, as a free radical scavenger, protecting enzymes and avoiding DNA damages. It has been also suggested the role of proline in prevention of lipid peroxidation and as a signalling/regulatory molecule, as well. Citrus sinensis cv. ‘Valencia late’ cell line is a salt-stress sensitive and the presence of NaCl higher than 200 mM leads to an increase in proline accumulation and a decrease in the specific growth rate (Ferreira and Lima-Costa, 2006). A positive influence on the alleviation of salt stress symptoms due to the presence of exogenous proline 5 mM, under 100 mM NaCl exposure, was clearly evidenced in this salt sensitive citrus cell line.

Keywords: citrus, cell line, proline, salinity

NEW FERTIRRIGATION TECHNOLOGIES TO IMPROVE NITROGEN ABSORPTION AND WATER MANAGEMENT (LIFE FERTIGREEN PROJECT FUNDED BY THE EUROPEAN COMMISSION)

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The aim of the ‘Fertigreen’ project was to test the effects of gas addition (CO₂ and O₂) into irrigation water in reducing nitrate requirements of several ornamental crops grown in the area around Chipiona (Cádiz, Spain) and thereby demonstrate a means for growers to reduce subsoil pollution from applied nitrate fertilizers. Treatments were imposed on 500 m² plots within commercial greenhouse crops of Chrysanthemum spp, Lilium spp, carnation, Zantedeschia aethiopica and Gladiolus spp grown at six different sites over two Spring and Winter seasons. Fixed doses of CO₂, with or without O₂, were added to every application of irrigation or fertigation with control plots receiving only the water nutrient solutions as applied to the commercial crop. Each test included 2 treatments with 5 replicates. For the long cycle crops, carnation and Z. Aethiopica the treatments were 300 and 400 ppm CO₂ and for the other crops they were 200, 300 or 400 ppm of CO₂. In most cases, gas addition decreased the irrigation water pH and increased solubility and absorption of some nutrients. Differences were measured in flower quality attributes, post-harvest life and leaching losses of nitrates which, in some cases, were significant.

Keywords: environment, gas, nitrates pollution, nutrients absorption, water management
SESSION 02
CYCLING AND TRACEABILITY OF NUTRIENTS IN MEDITERRANEAN-TYPE ECOSYSTEMS
Western Australian soils are among the most phosphorus-impoverished in the world. To survive on these soils, plants must have efficient mechanisms to acquire and/or use phosphorus (P). Efficient P-acquisition strategies include the production of various types of root clusters, which predominantly occur in non-mycorrhizal species on the most severely P-impoverished soils (Shane & Lambers 2005, Lambers et al. 2006). Efficient P-use strategies include a capacity to sustain relatively high rates of photosynthesis at extremely low leaf P concentrations as well as a high P-remobilisation efficiency and proficiency. Many Western Australian plants function at leaf P concentrations that are lower than those of plants in most other Mediterranean environments which reflects the P status of the severely impoverished soils in this region. Leaf P-resorption efficiency and proficiency of many species of the Proteaceae is higher than that in other Mediterranean ecosystems, and some of the measured values show greater proficiency than that observed for any other species (Denton et al. 2007).

Like in any other Mediterranean region, in the south-west of Australia, root growth and P acquisition predominantly occurs in the wet winter months, whereas P use for vegetative growth occurs later in the season, when temperatures are higher, but upper soil layers are too dry to take up nutrients. Because P acquisition and P use for growth are out of phase, Mediterranean woody plants require storage mechanisms. Storage of P in Western Australian woody species tends to occur in stems and roots, whereas in other Mediterranean environments, P is also stored in old leaves, which may accumulate P in winter (Mooney & Rundel 1979).

Species that naturally occur on P-impoverished soils typically show symptoms of P toxicity when P supply is elevated (Shane et al. 2004a, b), whereas closely related species from slightly less P-impoverished habitats are not negatively affected by an elevated P supply (Shane & Lambers 2006). This difference is based in part on a species’ capacity to decrease net P-uptake rates and thus avoid P toxicity. Non-mycorrhizal species from severely impoverished soils in Western Australia have a very large capacity to acquire P from soils that are too poor to sustain mycorrhizal plants, due to their “mining” strategy. Their root clusters mobilise P from sparingly available sources, due to the release of large amounts of carboxylates (Lambers et al. 2006). Mycorrhizal species, on the other hand, exhibit a “scavenging” strategy, acquiring P that is too far removed from the roots to arrive at the root surface by diffusion or mass flow; they tend to occur on soils with slightly higher P levels.

**Keywords:** non-mycorrhizal, phosphorus remobilisation, phosphorus toxicity, root clusters

NUTRIENT RELEASE BY DECOMPOSING RYEGRASS AND WHITE CLOVER CONTRIBUTES TO MINERAL NUTRITION OF GRAPEVINES

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Herbaceous crops grown in the vineyard alleys may represent a source of nutrients for grapevine. This study reports two experiments aimed at (1) understanding the decomposition and nutrient release by aerial organs of Lolium perenne (LP) and Trifolium repens (TR) and (2) characterizing the uptake of nitrogen (N) derived from decomposing material of LP and TR (Ndfr) by grapevines. LP and TR plants were labeled in pots with ammonium nitrate (¹⁵N at 10 % abundance, for a total of 10 g N m⁻²). LP and TR were cut and used to set two experiments both located at the experimental Station of the University of Bologna, Italy. In experiment 1, in April 2007, 2.04 g (DW) of N-labelled litter of LP and TR were placed into litter bags which were placed on the vineyard soil surface. Collection of bags LP and TR was performed 8 (June) and 16 (August) weeks from litter bags deposition. In experiment 2, 30 g plant⁻¹ of dry litter of LP and TR were placed on the herbicided soil under the grape plants. Leaves were collected 8 and 16 weeks from litter deposition; at 16 weeks, shoots including bunches were collected. Results show that the remaining of LP and TR residues was of 44.73 and 46.93% of DW at 8 weeks and 28.94 and 27.59% at 16 weeks, but the release of nutrients was different for LP and TR and varied according to the mineral element. Grapevines recovered similar amount N of LP and TR residues.

Keywords: cover crop, ¹⁵N, N recovery, Vitis vinifera
TOWARD A PREDICTIVE MODEL FOR THE ESTIMATION OF NUTRIENT NEEDS IN APPLE ORCHARDS

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The inappropriate use of fertilizers in orchards causes a decrease in fruit quality and environmental pollution; under sustainable agriculture, it is therefore necessary to determine the actual amounts of nutrients required by productive fruit trees to reconcile environmental and economical aspects. With this view we developed a model able to predict the amount of nutrients absorbed by apple trees during each vegetative season. The model is working for Fuji and Gala cultivars grafted on an M9 rootstock, but it will be upgraded for other cultivars. The model is based on the esteem of tree annual growth and its allocation to the new biomass. The amount of nutrients absorbed by trees during each vegetative season is calculated on the basis of the annual growth and the nutrient concentration of single organs. Tree organs considered are: pruning wood, branches, trunk, roots, fruits and abscised leaves. Allometric relationships based on data provided by excavation of apple trees have been obtained. These equations permit to determine the tree biomass based on simple parameters as tree age, trunk/rootstock diameter and planting density. A database of nutrient concentration of tree organs has been created. These data have been integrated in an electronic spreadsheet (available on the Internet at the European project ISAFRUIT web site) calculating the amounts of nutrients needed to support growth and production. These parameters are easily available by the possible end user (growers or extension services) and make the model an useful tool for the determination of fertilization based on tree requirements.

Keywords: apple, model, nutrition, sustainability
EFFECTS OF WARMING, WATER AND NUTRIENT AVAILABILITY ON NITROGEN ACQUISITION AND ALLOCATION: CAROB AS A CASE STUDY

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Taking into consideration the climate conditions predicted for the Mediterranean-type climates by the IPCC models for the coming decades, plants will be facing environments with higher temperatures, less water and increased nitrogen availabilities. Can we predict how Mediterranean crops will respond to these changes?

In this work we take the carob tree (*Ceratonia siliqua* L.) as a model plant and check the effects of several growth conditions on the plant morphology, physiology and phenology.

Carob seedlings were grown under several combinations combining: below- (10 - 40 °C) and above-ground (10 - 40 °C) temperatures; root environment pH (4 to 9), potassium and calcium concentrations (1 to 10 mM), nitrogen concentration (0.5 to 6 mM) and form (nitrate, ammonium nitrate or ammonium). Plants were also grown under deficiency of one of several nutrients (nitrogen, potassium, calcium, magnesium or phosphorous), and under water stress conditions. The effect of arbuscular mycorrhiza was also assessed.

The results obtained show that the plant responds to the distinct combinations of treatments by adjusting: the relative investment of biomass in the roots and shoots, the morphology and architecture of roots and shoots and by changing the relative allocation of carbon and nitrogen to the distinct organs. Altogether the results highlight that warming significantly increased total aboveground biomass accumulation, but the effects on the C/N ratio of the plant tissues, and consequently on the sink of CO₂ was dependent on the initial nitrogen, mainly on the nitrogen form, availability, as well as water availability which significantly affected the nitrogen and water use efficiency of the plants.

The long-term implications of these changes in N uptake and C fixation, which differ depending on the species and plant tissue, indicate significant effects of warming on the C and N cycle and on general ecosystem structure and function, eg. through plant-herbivores relationships or decomposition rates. From an agronomical perspective these results emphasize the importance of carob as a true Mediterranean crop deserving investment and an adequate management, particularly in more arid zones.
STUDY ON GRAPEVINE NUTRITIONAL STATUS: I. RELATIONSHIPS BETWEEN LEAF NUTRIENT CONTENTS AND SOIL CHARACTERISTICS

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The possibility of efficiently determining the nutritional status of a crop, in order to optimize the fertilization management and reduce its environmental impact, assumes great importance, particularly for tree or pluriennal crops, because “interrogating the plant” is undoubtedly the best way to know what to do.

In this paper, the results of a research aimed at investigating the relationships between different soil chemical-physical characteristics and nutrient concentrations in leaf tissues, on wine grape, are reported. The main feature of the experimental site, its high soil spatial variability, has allowed to examine the interested aspects keeping constant crop variety, plant age, climatic conditions and agronomic techniques management, whose variability is often cause of data misinterpretation.

The research was carried out in 2002 on a wine vineyard, cv Trebbiano toscano grafted on 1103P, in Southern Italy. On the experimental field, ten areas characterised by different soil average fertility were selected and, in each area, two representative plants were chosen. Soil samples at three depths and leaf samples at two phenological stages (fruit setting and veraison) were collected.

In the soil, total N content was positively correlated with total organic C, available P and exchangeable K and inversely related to total CaCO₃ content. Among the leaf mineral nutrients, P showed the highest variation in relation to soil parameters (positive correlation with N content, organic C, available P; negative with CaCO₃) in both the phenological stages. Total leaf N was positively correlated with soil organic C and available P only in the second sampling time. Moreover, in this stage, it was found a higher Ca and Mg leaf content in the areas characterised by a lower chemical fertility (lower total N, organic C; higher CaCO₃).

Keywords: grapevine, leaf nutrient concentrations, soil characteristics
MINERAL CONCENTRATIONS IN LEAF DRY MATTER AND LEAF AND PETIOLE SAP IN STRAWBERRY DEPEND ON LEAF AGE AND PLANT DEVELOPMENTAL STAGE

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Analysis of leaf dry matter is valuable when assessing the plants nutritional status, and for fertilizer evaluations in perennial crops. Methods for analyses of strawberry leaf and petiole sap have now become available, and nutrient concentration in sap should reflect changes in nutrient uptake within shorter time than leaf dry matter analysis. The use of fertigation has made it possible to change fertilizer application rates at any time during the season, suggesting leaf sap analysis to become a useful tool. The present field trial aimed to indicate reference leaf and sap nutrient values during the season in the strawberry cultivar Korona.

Young leaves, first fully developed leaves and old leaves were sampled five times in the first harvest year and twice in the second harvest year, at defined plant developmental stages during the season. Leaf dry matter and sap were analysed for several essential nutrients. Both leaves and petioles were used for sap analyses, while only the leaf lamina was used for dry matter analysis. A constant fertilizer rate was applied through the drip irrigation system from May to August, but the results demonstrated a large variation in concentration of mineral elements in both dry matter and sap due to differences between years, leaf age, time in the season or plant developmental stage. Leaf sap analyses may offer an improved description of the actual nutrient uptake for some of the minerals during the season, if further developed and standardized. Nutrient remobilisation in the plant as well as plant part analysed should be considered.
FINE ROOT GROWTH AND LONGEVITY IN A HIGH-DENSITY PEAR ORCHARD ON QUINCE C ROOTSTOCK AS AFFECTED BY NITROGEN SUPPLY

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Root development of quince C (Cydonia oblonga) genotype used as a rootstock for pear (Pyrus communis), cv. Abbé Fetel was studied with the minirhizotron technique. The orchard was located in the Po Valley near Bologna (Northern Italy). Trees were planted in February 2003 and spaced 3.8 m between rows x 0.9 m along rows. Drip irrigation (with emitters at 0.9 m) was provided to all trees. Orchard floor management included herbicide strips along tree row and grassed alleys. Besides control (unfertilized) trees, there were trees fertigated with urea-N and others fertigated with an organic soluble N fertilizer, obtained by enzymatic hydrolysis of animal connective tissue (collagen). When provided, nitrogen rates amounted to 48 kg N/(ha*year). The root study was carried out during 2004 and 2005. Fine roots were observed by minirhizotrons of 70 cm depth inserted into the soil at 30 cm from tree trunk and drippers. Root images were taken and analyzed by WinRHIZO Tron MF software.

Although we observed a higher number of new roots in 2004 than in 2005, in both years root birth mainly occurred in late winter-spring and, with less intensity, in autumn. The distribution of new roots along the soil profile differed in N-fertilized and unfertilized trees. In the unfertilized trees, roots number decreased with soil profile, while in fertilized ones, root growth distribution was homogenous. Fine-white roots had an average diameter of 1.3-1.5 mm, regardless the time of the year, the N regime and the soil depth. Root longevity assessed as the average period between their first appearance and the moment they turned brown, was unaffected by N supply but changed over time, being lowest spring (often less than 20 days), intermediate in summer and highest in autumn (often > 100 days). Interestingly, most (68%) white roots observed at the end of November 2004 were still present in February 2005 as white roots, while 8% turned brown and 24% disappeared.

These preliminary results suggest that the N fertilization at the rates used in the present study only affected the distribution of new roots along the profile, but had not effect on total root growth, root diameter and root longevity. In contrast with most published literature in other fruit crops, most roots of quince C have survived to winter as white roots, so they are potentially very efficient to take up nutrients as soon as spring growth occurs.
LEAF CONTENT OF MACRO AND MICROELEMENTS IN VITIS VINIFERA CV. SAUVIGNON BLANC

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Sauvignon Blanc is a widespread and popular grapevine variety for the production of high quality white wines in the Plešivica vine-growing region (Croatia). Soils of the Plešivica vine-growing region are of heavy mechanical composition, low air capacity, and high CaO concentration (30 %); all this favours formation of HCO₃⁻ ions, which cause disturbances in the uptake of biogenic elements and different types of chlorosis. The research objective was to determine the contents of biogenic macro and microelements in Sauvignon Blanc vine leaf in dependence on the health status (healthy or chlorotic) and age of vineyards (young or old plantation). Investigations included two production vineyards (planted on SO4 stock) on calcareous soil, with average CaO concentration of 30 %, of different plantation age (4 and 15 years). During the 2006 growing period, leaf material was sampled 4 times (twice before, and twice after flowering). Concentrations of the following elements were measured: macro (N, P, K, Ca, Mg) and micro (Fe, Mn, Zn). During the growing period, total nitrogen values ranged from 1.42-3.96 % N, phosphorus 0.20-0.42 % P, potassium 1.08-1.46 % K, calcium 1.42-4.65 % Ca, magnesium 0.14-0.63 % Mg, iron 60.17-161.90 mg Fe kg⁻¹, manganese 44.02-122.30 mg Mn kg⁻¹, zinc 16.66-20.54 mg Zn kg⁻¹. Vineyard age had a significant influence on the concentrations of all microelements and manganese while there were no differences in zinc and iron contents. Sampling dates affected the biogenic elements concentrations whereas no statistically significant difference in their contents was determined between healthy and chlorotic vine-stocks.

Keywords: biogenic elements, chlorosis, grapevine, lime
MACRO AND MICRONUTRIENT DEMAND IN PEACH TREES

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Mineral elements are generally supplied in routine treatments, often ignoring the real nutritional status of trees. Thereby, application of fertilisers on a regular basis can lead to an excess of available nutrients in relation to the real nutrient demand of crops. Such surplus can be either immobilised in the soil or leached, and can contaminate superficial and subterranean waters. To avoid an excessive use of fertilisers it is important to know both the actual nutrient status and the real nutrient demand of the tree for macro and micro-elements. The aim of this work is to attempt to estimate the nutrient budgets in peach trees. The real nutrient demand was estimated by measuring losses due to output of nutrients at different events, including wood pruning, flower loss, fruit thinning, fruit harvest and leaf fall. An estimation of the amounts of nutrients immobilized in wood and roots was also carried out. Samples from two different peach orchards (*Prunus persica* L. Batsch) grown on calcareous soils in the Northeast of Spain were used for this estimation.

The first orchard corresponded to 15-year-old trees cv “Babygold-5” and “Catherina” grafted on GF 677, planted with a 2,5x2 m frame, approximately 3,5-3,25 m high, with a trunk diameter of 11-13,3 cm and a flood irrigation. The second orchard was flood irrigated and had 7-year-old trees of cv. “Calanda” grafted on a peach-almond hybrid, with a 4x6 m frame and approximately 3,8 m high and with a trunk diameter of 14,5 cm. A third estimation was made on two-year-old trees growing on a peat-sand substrate.

Keywords: mineral nutrition, nutrient budget, peach

Acknowledgements: This study was supported by the Spanish Ministry of Science and Education (Projects AGL2006-1416 and AGL2007-61948, co-financed with FEDER) and the Commission of European Communities (project Isafruit).
STATUS OF MICROELEMENTS IN MANDARIN ORCHARDS AT MONTENEGRIN SEASIDE

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The investigations were related to 24 mandarin orchards planted at alluvial-delluvial soil and different types of cambisol at Montenegrin Seaside. The status of microelements in soils and leaves were researched. Basic soil parameters such as pH (active and potential acidity), total carbonates, humus, available phosphorus and potassium were determined by standard analytical methods. Contents of microelements in soils and leaves (Fe, Mn, Cu, Zn and B) were determined by atomic absorption spectrophotometry and spectrophotometry; after extraction with DTPA and hot water as well as nitric-perchloric acid digestion.

Concerning microelement supply of citrus, Zn deficiency was stringently marked. The fifty percent of investigated mandarin orchards had low and very low content of available Zn, 38% medium and 4% high and very high. However, almost at all orchards, Zn contents in leaves were below or very close to deficiency limit (<16 ppm). Zinc deficiency symptoms as “interveinal chlorosis” and a rosette-like whirl of stunted leaves (small and narrow) were in great appearance.

The contents of boron in leaves and soils were at medium level. In the contrary of Fe and Mn contents in soils, which classified them as rich or very rich, Fe and Mn contents in leaves were low and very low in the majority of orchards. Increasing of Cu content in orchard soils in comparison with non-cultivated soil (same type) was followed by increasing of its content in leaves. It can be caused by long-term use of copper based-compounds for plant protection.

Keywords: leaves, mandarin, microelements, soil
Preliminary Observations on the Quantity of Mineral Elements the Grower Annually Remove from Apple Orchards as Related to Genotype and Training System

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The quantity of mineral elements an orchard needs to produce a certain apple fruits yield has been investigated in 2 orchards in Valtellina. In the first (Sondrio) of them Tentation and Red Chief, Spindel trained, were considered. In the second one (Ponte in Valtellina), Galaxy and Golden Smoothee, Solaxe and Spindel trained were considered.

For each cultivar, year and training system, the sample of fruit at harvest and branches and twigs material after pruning, has been collected to determinate dry mass and mineral composition. The quantity of macro and micro nutrients the apple plant uptakes from the soil for the production of about 20-70 ton/ha was influenced especially by genotype and also by training system.
ACTINIDIA DRY MASS PARTITION AND ITS RELATION WITH MINERAL COMPOSITION OF DIFFERENT ORGANS IN TWO TRAINING SYSTEMS

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Female and male Actinidia plants of 25 years old trained at “ Pergoletta ” and “ Tendone ” were destroyed to determine annually quantity of dry mass produced by fruit, leaves, canes. Also the total dry mass produced in the whole cycle by main branches, trunk, collar and roots was weighted. For each of these organs or their parts mineral composition was determined. Kind of organs, sex of plants and training system showed a strong influence on the results.
COMPARISON THE PATTERN OF FRUIT GROWTH AND DEVELOPMENT IN SOME IRANIAN PISTACHIO CULTIVAR IN RELATION TO MORPHOLOGICAL AND MINERAL ELEMENT CHANGES

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Study of effective factors on formation of initial fruits and awareness of mineral element changes during the different stages of fruit growth and development are necessarily important in orchard management. Therefore, the changes in some morphological and mineral nutrient changes were evaluated in some Iranian pistachio cultivar (i.e. Akbari, Kalle-Ghoochi, Ohadi and Rezaii-Zoudras) and was done as factorial-split in time based on randomized complete block design with 4 cultivars, 2 bearing levels (i.e. “On” and “Off” trees) and 3 replications. Sampling was done in different stages of fruit growth as DAFB till harvest time. Length, diameter and width were considered as morphological traits and Mineral elements (i.e. N, P, K, Ca, Mg, Zn, Fe, Cu and Mn) were also measured during the fruit growth and development. Results showed that all cultivars followed double sigmoid growth pattern in which the most obvious change was relatively rapid growth in size and weight within 30 days after full bloom (DAFB). In a long period time between 30 to 120 DAFB, the lag phase occurred and interrupted fruit growth. After that, fruit growth resumed in a short period and whole fruit attained its ultimate size at harvest time. Most of morphological, and mineral elements traits were significantly different among cultivars and bearing levels. Study the mineral elements changes during the growth season suggested that fruit as a strength sink absorb most of mineral elements during the preliminary stage of fruit growth and it seems that this phenomenon is in relation to fruit and embryo development.

Keywords: mineral element changes, morphological changes, pattern of fruit growth and development, pistachio
RHIZOSPHERIC CHANGES AND PERFORMANCE OF CITRUS ROOTSTOCKS

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Renewed attempts are in progress to find out ways and means to raise crop at low input use. Nutrient cycling by exploiting the microbial diversity within rhizosphere is one such promising option, nearly unexplored in citrus. In this background, the studies were carried out to ascertain variation in growth of 15 well known citrus varieties (2 lemon varieties, 2 limes, 7 sweet oranges, and 4 citrus hybrids) vis-à-vis microbial features of rhizosphere and nutrient acquisition pattern on sandy loam textured acidic Alfisol representing humid tropical climate of northeast India.

Pre-bearing response of different varieties for two years showed a significant difference ($p < 0.05$) with respect to girth and canopy volume. Maximum canopy volume ($m^3$) of Bears lemon (0.939) was observed followed by Lisbon lemon (0.589), Mexican lime (0.557), Early Gold (0.487), and Eureka lemon (0.447) with Cara Cara Navel displaying poorest canopy expansion (0.262). Variation in girth registered a similar variation, being highest in Bears lemon (9.80 cm) and lowest in Cara Cara Navel (0.261 cm). As much as 88.9% variation in canopy volume was addressed by root density ($r = 0.889$, $p = 0.01$). The root density (g/cc soil) was observed to be maximum in Bears lemon (0.523) followed by Lisbon lemon (0.498) ≥ Early Gold (0.487), Mexican lime (0.473), and Eureka lemon (0.442) with varieties like Cara Cara Navel (0.262), Trovita (0.291), and Rhod-E-Red (0.271) showing minimum root density. Roots adding up humate substances using organic carbon (g/kg) as an index of soil fertility within the rhizosphere was positively correlated ($r = 0.769$, $p = 0.01$), bringing maximum increase from an initial value of 2.88 to 3.21 (0.33 net increase) under Bears lemon and lowest increase to only 2.90 (0.02 net increase) under Cara Cara Navel/Rhod-E-Red. Count on bacterial population within the rhizosphere showed a striking variation ($p < 0.05$) maximum being under Bears lemon ($86 \times 10^7$) and minimum under Cara Cara Navel/Trovita ($48-52 \times 10^6$). Leaf nutrient concentration by different varieties further revealed that Bears lemon (1.92% N, 0.06% P, 23.8 ppm Zn) and Lisbon lemon (1.90% N, 0.07% P, 25.2 ppm Zn) besides lower to other varieties regulated a much better growth through microbiologically fertile rhizosphere.
SESSION 03
LOW INPUT AND PRECISION AGRICULTURAL SYSTEMS
Nutrient management is quickly becoming a key issue in tree crop production in California. Proposed regulations and market demands are placing restrictions on nutrient application to all orchard crops in California. Currently there is insufficient knowledge of the relationship between individual tree and whole orchard yield variability and the impact of this variability on the efficiencies of nutrient use and the optimization of tree yield. To advance from management at a whole orchard level to management at a finer scale will require the development and application of precision agricultural techniques. To date, however, there has been only very limited application of precision management to tree crops and few tangible benefits have been realized. The challenges of applying precision agricultural practices to tree crops include engineering solutions to measure yield variability and to provide spatially variable fertilization, and biological and statistical challenges to interpret, model and ultimately predict spatial variability in nutrient demand and response.

Recent technological advances in precision harvesting of Pistachio have allowed for the collection of individual tree yield data over the past six growing seasons on 4,000 – 10,000 individual trees. This is the largest and most spatially refined data set ever collected from a tree crop. Results from this experiment highlight issues of management inefficiencies, gaps in research protocols, and provide insight into pistachio physiology and the causes of yield variability. These results also highlight the opportunities and challenges to the adoption of variable rate fertilization in trees. Results clearly demonstrate that the homogenous application of fertilizers as currently practiced, results in substantial inefficiencies with some trees being persistently over-fertilized while others are chronically malnourished. Post hoc analysis and model building exercises, provide insight into the economic and environmental impact of the existing nutrient management regime and allow for the validation of new approaches that considers both spatial and temporal variability in yields and hence nutrient demand. Results suggest that simple advances in yield modeling or spatially variable fertigation (SVF) have the potential to dramatically alter the economic and environmental sustainability in these orchards. Detailed analysis of the patterns of yield variability show substantial spatial and temporal autocorrelation which invalidates traditional statistical approaches and highlights the need for new research approaches to determine when, where, and how blocks and treatments are placed and how results must be analyzed.

The benefits of precision yield determinations, however, extend beyond management practice and this experiment has provided critical information that improves our understanding of the balance of physiological and environmental mechanisms that determine yield variability. Information on the patterns and extent of yield variation within and between years and a discussion of the biological mechanisms of yield fluctuation will be presented. The impact of this research on the efficiency of nutrient management and tree response will be discussed.

**Keywords:** alternate bearing, fertilization, modelling, nutrient use efficiency, NUE, spatial statistics, yield variability
ASSESSING THE CURRENT PLANT NUTRITIONAL STANDARDS IN THE AUSTRALIAN WINEGRAPE INDUSTRY

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In Australia, the most commonly used standards for assessing grapevine nutrient status utilise the petiole collected from the leaf opposite the basal bunch taken at flowering. These standards were based on the Californian standards developed for Thompson Seedless cultivar and modified with reference to survey work and field trials conducted in southern Australia. In recent times, there have been questions raised regarding the validity of these standards for widespread application to other cultivars, scion-rootstocks combinations, and wine growing regions.

In attempt to assess the value of the current standards, leaf samples from three grape varieties, Shiraz, Cabernet Sauvignon and Chardonnay were collected from eight wine growing regions in Australia. The relationships between these samples collected at flowering, veraison and harvest and between leaf petioles, leaf blades and soil types across the vineyard were correlated against yield (kg/vine and berry weights) and quality parameters (Brix, pH, TA and colour).

Preliminary results have indicated that potassium concentrations in petioles at flowering are highly correlated to yield across a number of wine regions, however in leaf blades, the concentrations of iron, zinc and magnesium at veraison were better correlated to yield. Calcium concentrations at flowering regardless of leaf sample type (petiole or blade) were more strongly correlated to juice pH than samples at veraison.

Nutrition, yield and quality results will be presented with reference to the current nutritional status and available plant standards with recommendations and implications discussed to determine optimal sampling time to best achieve production goals.

Keywords: blades, correlations, petioles
INCREASING FOLIAR ZN:NI OR CU:NI CONCENTRATION RATIOS INCREASE SEVERITY OF NICKEL DEFICIENCY SYMPTOMS

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The influence of essential micronutrients on the endogenous bioavailability of Ni is unknown. This study examines the linkage between Ni deficiency and endogenous foliar concentration of Ni, Zn, and Cu. We hypothesize that expression of morphological symptoms of Ni deficiency by pecan [Carya illinoinensis (Wangenh.) K. Koch] can depend on the ratio of either Zn, or Cu, to Ni in symptomatic foliage.

The hypothesis is tested in a greenhouse study using ‘Desirable’ seedlings trees growing in an orchard soil known to cause Ni deficiency in potted trees. Amendment of the potting soil with various amounts of either Zn-sulfate or Cu-sulfate produced seedling trees possessing a variety of Zn:Ni and Cu:Ni concentration ratios, and growth/morphological symptoms exhibiting different degrees of Ni deficiency. Symptomatic trees were later foliar-treated with Ni-malate, from Alyssum sp. biomass; hence, correcting deficiency symptoms in the subsequent year’s growth.

Severity of Ni deficiency was unrelated to foliar Ni concentration, but strongly linked to foliar Zn: Ni or Cu: Ni ratios. Deficiency symptoms increased sigmoidally with increasing Zn: Ni or Cu: Ni ratio, and were correctable, regardless of the Zn: Ni or Cu: Ni ratio in seedling trees, by a single foliar application of Ni-malate extracted from Alyssum biomass. Soil Zn or Cu supplements did not detectably affect foliar Ni concentration. These data indicate that Ni deficiency occurring in pecan orchards is possibly caused by either Zn or Cu fertilization induced reductions in the physiological availability of Ni. A reduction in Ni’s bioavailability to physiological process might be due to either competitive inhibition or sequestration.

Keywords: Carya, pecan, replant, tree
WHOLE KIWIFRUIT VINE STUDIES ON MINERAL NUTRITION AND FRUIT QUALITY

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Hort16A is a gold-fleshed kiwifruit that has been grown commercially for around 10 years. The main differences between Hort16A and the green-fleshed Hayward kiwifruit are that Hort16A vines break bud about 1 month earlier than Hayward vines, when soils are much colder, Hort16A vines are more vigorous and produce higher crop loads than Hayward vines. We have little information comparing the nutritional requirements of green and gold kiwifruit, and how treatments designed to increase the taste of gold kiwifruit affect nutrition uptake. We excavated entire Hort16A vines excavations at three-weekly intervals for 1 year to compare the timing and magnitude nutrient accumulation and distribution between Hayward and Hort16A vines. In a second trial we applied trunk girdling, a technique commonly applied to Hort16A vines to increase fruit dry matter contents, to vines. After three years entire vines and an equal number of non-girdled control vines were excavated. The effects of the girdling treatment on nutrient uptake and distribution and on fruit quality will be discussed.

Keywords: \textit{A. chinensis, A. deliciosa}, fruit quality, nutrient distribution
NITROGEN UPTAKE, GROWTH AND BIOMASS ACCUMULATION IN THE FIRST GROWING SEASON OF CHERRY TREES OVER GISELA® 6

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The objectives of this study were to determine growth, diameter and height, and annual biomass accumulation and allocation among different components in Cherry trees cv. Bing over Gisela® rootstock fertilized with different amounts of N, and to calculate their nitrogen requirements for the first growing season after establishment. An experimental plot was established in central Chile, where plants receive 0, 60 or 120 kgN ha⁻¹, according to a complete randomized design. The experimental unit was a group of 9 plants and each treatment had 4 replicates. Diameter and height of three plants per replicate was measured 2 to 4 times per month, between October 2006 and April 2007, and were analyzed using mixed linear models, including an autoregressive structure and random effects for the measurements in each tree. Also, at the end of the growing season a destructive analysis was used to separate the different biomass components. Total nitrogen uptake ranged between 9 and 13 kg N/ha⁻¹, and no significant differences on biomass yield among treatments were detected. Biomass annual growth ranged between 700 and 1000 kg of dry matter ha⁻¹. When biomass was divided among components, significant differences on dry matter allocation were found only for fine roots. For diameter and height growth, different significant random effects were found, with no significant differences between nitrogen dose treatments. This suggests that during the first growing season cherry plants on dwarfing rootstocks have low nitrogen demand and low N uptake efficiency.

Keywords: cherry rootstocks, mineral uptake, mixed linear models, nitrogen
NITROGEN FOLIAR UPTAKE AND PARTITIONING IN CABERNET SAUVIGNON GRAPEVINES

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Avoiding nitrogen (N) deficiency in Vitis is necessary to satisfy its annual budget. Foliar nutrition is a rapid method to decrease temporary N deficiency by reducing uptake period during the vegetative and reproductive season. To better understand N uptake dynamics by foliar spray supplying and its partitioning in vine organs, labeled N (¹⁵N) methodology was used in the present study.

The trial was done in the IASMA vineyard on fifteen - years old vines of the cv. Cabernet Sauvignon raised by a cordon spur training system. Foliar N nutrition was applied during four main phenological phases (pre-flowering, pre-bunch closure, veraison and harvest) at four vines per phase with an ammonium sulfate solution where ¹⁵N was enriched to 10 atoms %. Each vine was fertilized with 10 ml of solution applied in both pages of leaves receiving a total of 21.2 mg of labeled N. After one week the vines were destructively harvested and then divided in the following organs: axis of shoot, leaves, bunches and/or inflorescences, wood, bark, fine (<2mm) and coarse (>2 mm) roots. Each organ was dried and weighted and a sample was used for N uptake determination.

The data showed a large difference in N uptake efficiency between the phenological phases. In pre-flowering the efficiency was of 38.0 %, in pre-bunch closure was of 30.0 %, at veraison was 21.7 % and at harvest was 66.0 %. This difference can be explained by quantifying the rain fallen after the treatment related to the number of days after the treatment.
Iron deficiency (or Fe chlorosis) is a very common nutritional problem in fruit trees grown in calcareous soils. Trees suffering from Fe chlorosis show yellowness in younger leaves, reduction of vigour, fruit quality and in severe cases entire tree can die. For that reason, it is advisable to determine which soils induce Fe chlorosis. We studied the soil properties of the main crops in the Mediterranean area (olive tree: ‘Hojiblanco’, ‘Manzanilla’ and ‘Picual’, and grapevine) related to the degree of Fe chlorosis. To this purpose, we related the index of chlorophyll content (SPAD values) with the soil properties beneath each plant at the deep of maximum root density. Iron extracted by oxalate, citrate, DTPA and hydroxylamine were positive and significant related with the SPAD data. However, hydroxylamine extractable Fe (Feh) provided the best estimation of chlorophyll content in olive tree and grapevine. Iron in hydroxylamine extracts was related to poorly crystalline Fe oxides, contributing to explain the merit of this method for predicting the incidence of Fe chlorosis in the studied group of soils. The “active” lime method (ACCE) only was a significant variable for olive ‘Picual’.
In sweet cherry, nitrogen (N) and carbon reserves accumulated the previous fall are the only source available to support early spring growth. To complement soil N supply, Chilean growers have been using foliar urea applications after harvest. So far, the information regarding the application time and its effectiveness in this practice is scarce. To study the aerial distribution of N applied in the form of foliar sprays, an experiment using "Bing"/"Gisela 6" three-yr old sweet cherry branches was carried out in 2007. A total of 42 branches were labeled using $^{15}\text{N}$-urea (10% atom) in early (Jan) and late postharvest (Mar). At each date a separate group of branches was used to label only one of the three leaf populations [i.e., fruiting spur leaves (FSL), non-fruiting spur leaves (NFSL) and current season shoot leaves CSSL]. Each leaf population constituted a treatment. Leaves were hand painted with $^{15}\text{N}$-urea on both sides of the blade using a thin brush. Labeled branches were destructively removed 15 days after the labeling and in winter (Jun, 2007). There was no influence of the application time on $^{15}\text{N}$ partitioning for all treatments. At early and late postharvest, FSL, NFSL and CSSL were able to take up and translocate $^{15}\text{N}$. Regardless of the treatment, the highest $^{15}\text{N}$ enrichment was found in the fruiting segment of the branch. In terms of $^{15}\text{N}$ partitioning, the highest percentage was found in the bark of all treatments, but the highest $^{15}\text{N}$ concentration was found in buds of the directed labeled section. Branches removed in winter showed a lower $^{15}\text{N}$ levels suggesting translocation out of the branch.

**Keywords:** fruit growth, Gisela®, partitioning, rootstocks, stable isotope
NITROGEN UPTAKE AND PARTITIONING IN SWEET CHERRY AS INFLUENCED BY TIMING OF APPLICATION

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The objective of this work was to determine nitrogen uptake and partitioning in sweet cherry trees planted in a cold region (Los Antiguos, Santa Cruz, Argentina; 71°38’ W, 46°32’ S), as influenced by timing of the fertilizer application. Nitrogen (95 kg/ha) was applied as ammonia nitrate to a soil with 7 year-old sweet cherry (Prunus avium ‘Bing’) trees grown on P. mahaleb rootstocks. Fertilization was split in two equal applications per treatment: (1) the commercial product and (2) the product labeled with ¹⁵N isotope (10% atom.). Treatments consisted of one spring (October 2005) or one summer (January 2006, after harvest) application of ¹⁵N ammonium nitrate to three replicate trees. Fruit were harvested in January and leaves were sampled at both full canopy and leaf fall. All trees were excavated in winter (August 2006) and partitioned into their components. These were subsampled, dried and analyzed for total N and ¹⁵N content. Total N per tree was 127.41 and 88.05 g for spring and summer treatments respectively. Nitrogen content derived from the fertilizer was similar in both treatments (17.52 and 18.29 g per tree respectively; p=0.715). Summer post-harvest ¹⁵N application partitioned not only to the trunk and roots but also to buds and leaves. Uptake efficiency was significantly (p=0.0087) higher in the spring than in the summer application (49.95% versus 29.84%). Nevertheless, the postharvest nitrogen fertilization seems to be important in the reserve accumulation as a significant percentage of spring-applied nitrogen is usually lost due to harvest and summer pruning.

Keywords: ¹⁵N isotope, N uptake efficiency and N distribution, Prunus avium L. fertilization
The presence of plants able to develop symbiosis with nitrogen (N)-fixing microorganisms is encouraged in sustainable agriculture, as this decreases the need for N fertilizer addition. Biological N fixation is widespread among Fabaceae, but legume species differ in their ability to develop symbiosis with N-fixing microorganisms: for example, while this frequently occurs in the sub-family Papilionoideae, only about 5% of the species of the sub-family Cesalpinoideae have developed such symbiosis mechanism. Carob (Ceratonia siliqua L.) is an evergreen legume tree belonging to Cesalpinoideae, typical of the Mediterranean basin, used for animal feeding, but with a great potential as a crop for the food industry. The ability of carob trees to develop symbiosis with rhizobia is unclear: root nodules have not been found in nature but were formed on roots of inoculated carob trees. We have applied the 15N natural abundance technique to field grown carob trees in Sicily and Sardinia (Italy) to assess the potential contribution of atmospheric N for tree metabolism. As soil derived N is generally more enriched in 15N than atmospheric N (δ15N=0 ‰), if a tree uses atmospheric N through the root symbiosis with N fixing microorganisms, then the 15N abundance in its tissues should be significantly lower than that of a tree deriving all its N from the soil. Leaf sampling were performed in six locations in different periods of the year from mature carob trees and from adjacent trees either normally-able (Spartium junceum or Robinia pseudoacacia) or unable (control trees, like Olea sativa, Olea oleaster, Arbutus unedo, Pistacia lentiscum) to develop symbioses with rhizobia. Soil δ15N ranged from 5.1 to 8.4 ‰. While leaves of trees known to develop N-fixing symbioses had δ15N lower than the others, leaves of carob trees always had similar values of δ15N than control trees. Data from the study do not support the hypothesis that field grown carob trees use N derived from biological fixation.
MEANS OF WEED CONTROL AND NITROGEN FERTILIZER AROUND APPLE TREES

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The initial aim of the trial was to find the best solution of agronomical practice to maintain strips around trees free of weeds. In this paper the main accent is on the availability of nitrogen for fruit trees. In the years 1976 – 1983 in Pure, Latvia a orthogonal factorial experiment with apple cultivar ‘Celminu Dzeltenais’ on seedling rootstocks was established, where the effects of three methods for controlling weeds along with a nitrogen fertilizer in the strips on the growth and cropping of the trees were investigated. The means of controlling weeds were: simazine 0.75 g·m⁻², 2.4D 0.4 ml·m⁻² and hand weeding. The nitrogen (N 120 kg·ha⁻¹) was given as ammonium nitrate. All factors were applied to strips. In the remaining area during the first four-years the soil was cultivated, but during the next four-years period sod mulch system was established. The weeds were almost completely controlled by simazine, but less efficiently – by the means of a hoe. The effect of 2.4D on the total amount of weeds was negligible, as only the dicotyledons were killed. During the first four years none of the four factors had significantly influenced the growth or cropping of the trees. During the second four-year period of the trial, when perennial grasses were grown in the rows of trees, the most effect on the yield of apples exerted the nitrogen fertilizer. The positive effect of simazine was less significant. Minimal, although present was the effect of hoeing. 2.4D had no significant influence on yield. The growth of trees was significantly enhanced both by nitrogen and simazine, but the effect of hand weeding was minimal. The possible specific role of simazine in nitrogen availability for fruit trees in connection with soil microbiological activity is discussed.

Keywords: herbicides, Malus, nitrogen, simazine, weed control
INFLUENCE OF SOIL REACTION ON MANGANESE CONTENT IN GRAPEVINE

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Influence of soil reaction on vine manganese content was investigated on Sauvignon variety in the Plešivica vine-growing region (Northwestern Croatia) in 2007. The trial was set up according to the strip-plot design with three replications, on two different soils: vitisol - dystric cambisol, pseudogleyic (pH \(_{KCl}\) 3.95) and vitisol - rendzina on marl (pH \(_{KCl}\) 7.35). Total manganese in acid soil ranged from 543 mg Mn kg\(^{-1}\) (0-30 cm) to 593 mg Mn kg\(^{-1}\) (30-60 cm), and in calcareous soil from 526 mg Mn kg\(^{-1}\) (0-30 cm) to 539 mg Mn kg\(^{-1}\). Identical tillage, fertilization and vine protection were applied in both vineyards. Manganese concentration in vine leaves was determined three times in the course of the growing period: at the flowering and verasion stages, and at the end of the growing period. At the end of the growing period (harvest), manganese content was also determined in must, mark and in cluster stem. At all samplings, significantly higher leaf manganese concentrations were determined on acid soil compared to calcareous soil. The highest leaf manganese concentrations were determined at the verasion stage on acid soil and were 3 to 5 times higher than optimal concentrations (30-100 mg Mn kg\(^{-1}\)). Manganese concentration in must was 2.3, in mark 2.1, and in cluster stem as much as 5.3 times higher on acid soil than on calcareous soil. Significantly lower manganese concentrations in must and mark than in leaves and cluster stems may indicate translocation of manganese from leaves and stems into berries.

Keywords: grapevine, manganese, must, soil reaction
EFFECTS OF LIMING ON STAR FRUIT TREES


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Soil acidity is one of the most important factors limiting agricultural production in the tropics. For this reason, the objective of this research work was to evaluate the effects of application of lime doses to soil and to monitor their benefits for the implantation of star fruit (*Averrhoa carambola* L.) trees, cv. Malásia, by chemical analysis of the soil, foliar diagnosis, biological evaluations and production. The experiment took place at the Citrus Experimental Station in Bebedouro, state of São Paulo, Brazil. The soil was a Typic Haplustox (V=26% at the 0 to 20 cm layer) between August 1999 and July 2006. The following doses of limestone were employed: 0; 1.85; 3.71; 5.56 and 7.41 t ha$^{-1}$. During 78 months after the experiment installation, soil chemical attributes were periodically examined. The trees, during this period had their leaves analysed as to micro and macro nutrient contents, their trunk diameter, height, and crown volume measured. For a period of 5 year the production of fruits was determined. Liming promoted a betterment in the evaluated chemical attributes of the soil: pH, calcium (Ca), magnesium (Mg), BS (bases sum), V (bases saturation), and hydrogen and aluminium (H+Al) from the upper 60 cm of soil when the samples were taken from both the line and between the lines of plants. In the plants, the levels of Ca and Mg were also found to increase. The highest fruit yields were observed when soil base saturations reached 45% on the lines and 50% between the lines as well as when foliar levels of 8.0 g of Ca and 4.7 g of Mg per kilogram of leaves were attained. The limestone dose of 7.41 t ha$^{-1}$ was sufficient to maintain the soil bases saturation at the depths of 0 – 20 cm close to 50% during the 40 months that followed the incorporation of the limestone whereas the dose of 5.56 t ha$^{-1}$ maintained that same level of acidity correction during 30 months after the application of the limestone.

Keywords: *Averrhoa carambola*, lime, mineral nutrition, soil acidity
PREVENTION OF KIWIFRUIT IRON CHLOROSIS
BY SUSTAINABLE FERTILIZATION AND SOIL MANAGEMENT STRATEGIES

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The traditional supply of synthetic Fe-chelate fertilizers for preventing and curing iron chlorosis symptoms in orchards and vineyards does not represent an economically and ecologically approach.

In order to evaluate the effectiveness of some sustainable strategies for preventing iron chlorosis of kiwifruit (Actinidia deliciosa), a field trial was performed (2004-07) in a mature commercial orchard (cv Hayward) located in the Po Valley area (Italy). The soil was clayey with sub-alcaline pH (7.7), low content of organic matter (1.5%) and moderate percentage of active lime (4.4%).

Water and nutrient requirements were satisfied by drip fertigation. Both in spring 2004 and 2006, the following treatments were applied to the soil: 1) neem cake (an organic waste dispaying inhibitor nitrification properties) at the doses of 1.2 and 2 kg plant\(^{-1}\), respectively; 2) compost (7.5 kg plant\(^{-1}\)) enriched with ferrous sulfate eptahydrate (0.5 kg plant\(^{-1}\)); 3) injection of synthetic vivianite (10 l plant\(^{-1}\)). In addition, the effectiveness of intercropping extended to the tree row with perennial graminaceous species (mixture of Lolium perenne, Poa pratensis, Festuca rubra), able to enhance soil Fe availability by root secretion of phytosiderophores, was evaluated. Control and soil Fe-chelate fertilized plants were also included in the experimental design. Starting from 2006, control plants showed clear leaf Fe-chlorosis symptoms, effectively prevented by all treatments, particularly by intercropping. The prevention induced by neem cake fertilization indicates the influence of both soil nitrate and ammonium availability on kiwifruit iron nutrition. Data collected during 2006, through the minirhizotron technique, suggest the effect of iron supply and soil management on root development.

Keywords: Actinidia deliciosa, intercropping, iron chlorosis, neem cake, phytosiderophores
EFFECTS OF SLOW RELEASE FERTILIZER ON CITRUS THOMSON NAVEL MINERAL STATUS

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A field experiment on a commercial citrus orchard was carried out with mature trees of Thomson navel orange (Citrus sinensis Swingle). The tree received the same fertilization amount but by two different fertilization methods. On one plot of half hectare the trees were fertilized with a slow release fertilizer composed with (17N-12P-18K +2Mg) buried 10 cm dip at the beginning of the spring tree flush growth (first week of April). A second supply was made at the beginning of autumn tree flush growth (end of August) with another composition of the slow release fertilizer (13N-5P-27K +2Mg). On another plot, the trees were fertilized with the same quantity using the drip irrigation system and well distributed during all the season growth.

The aim of this work was to study tree mineral status to the two fertilization methods. For that, leaf samples from spring flushes were collected in September and analyzed for N, P, K and Mg concentration. To determine the nitrogen status a SPAD measurement was also made from May to November each month. The result shows that SPAD values are higher with the slow release fertilizer than with fertigation during July and August.

Keywords: citrus, mineral status, slow release fertilizer, SPAD
The use of foliar analysis as a tool for the diagnosis of nutritional status of olive orchards (Olea europaea L.), as in other fruit species, has been made possible through the establishment of some reference foliar concentrations for each of the essential elements. In the case of nitrogen, it has been seemed there is deficiency when the foliar concentration is below 1.4% and that the level of this nutrient is suitable when the concentration is between 1.5 and 2%. It is not established an excess or toxicity level because of the fast transport of the excess nitrogen in leaves to other reserve organs. Based on numerous experiments about nitrogen fertilization carried out with young plants under controlled conditions and with adult trees under field conditions, and due to the lack of effects on yield and vegetative growth parameters observed, doubts about the accuracy of the nitrogen deficiency threshold established are raised. Similarly, these results suggest a new threshold, excess, from which fruit quality decreases and adverse effects on the agronomic performance of the tree can be observed. According to these preliminary data, we can suggest that the deficiency threshold could be located between 1.22 and 1.35% and an excess threshold is noticed, from which there are negative effects on agronomic parameters and oil quality, to around 1.7%.

Keywords: fertilization, foliar-analysis, nitrogen, olive
FLOWER CHEMICAL ANALYSIS IN THE DIAGNOSIS OF THE N NUTRITIONAL STATUS OF ORANGE TREES

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In species or varieties in which the flowering coincides with the beginning of the vegetative period, the chemical analysis of the nitrogen in flowers in substitution or complement of the leaf analysis carried out in the end of the preceding vegetative period has been developed by some authors for deciduous trees. For perennial trees, as in the case of citrus varieties of early flowering, flower analysis (which can be performed precisely at the beginning of the vegetative period) has been studied by some authors for the diagnosis of its N nutritional status as a more opportune alternative to foliar analysis (which is carried out in the end of the previous vegetative period). Based on the available data on a field trial with five N rates, in ‘Lane Late’ orange trees, carried out since 1999, in Algarve, we made a comparative analysis of the N concentration, under the different treatments, in leaves and flowers. From the results obtained it was possible to verify a high homeostasis for the N concentration in the flower, comparing with the concentration of N in the leaves. In a subsequent evaluation of the linear regression of the N concentration in leaves and flowers on the N fertilization experimental levels, it was possible to find determination coefficients of respectively 0.79 and 0.39 pointing out the high homeostasis for the N levels in the flowers. On the other hand, the regression coefficients (0.009 for flowers and 0.017 for leaves) confirm the higher homeostasis for N content on flowers.

Keywords: Citrus sinensis, flower analysis, foliar analysis, N nutritional status diagnosis
SEARCH OF CANDIDATE GENES EXPRESSED IN RESPONSE TO IRON DEFICIENCY IN PRUNUS ROOTSTOCKS

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Iron chlorosis is a nutritional disorder affecting a wide range of crops in the Mediterranean region. Iron is present in calcareous soils but it is not assimilated by the plant. The problem is particularly important in fruit trees where the use of tolerant rootstocks represents the best alternative to prevent iron chlorosis. The most common symptom produced under iron deficiency is the leaf chlorosis, due to the lost of pigmentation produced for the decrease of chlorophyll content in the chloroplast. The iron deficiency produces as well other physiological changes in the plants like the induction of the iron reductase activity or modification in the expression of the genes involved in iron transport. The search of tolerant rootstocks is being studied in a F₁ population derived from a three ways interspecific cross between the myrobalan (P. cerasifera): P 2175, and the almond x peach hybrid (P. dulcis x P. persica): Felinem (formerly GxN 22). The two parental of this population, grown in hydroponic culture, are being individually analyzed to know their behavior under iron deficiency conditions. Preliminary results show differences in the chlorophyll content of the chlorotic leaves. The induction of ferric chelate reductase activity is also being measured. The approach of the candidate genes analysis to identified genes involved in the induction of this enzyme, reported in other vegetable species, is being implemented based on in silico screening of genes expressed under iron deficiency in roots, such as those encoding the ferric reductase FRO2 or the iron transporter IRT1.
In order to further deepen some aspects of plant mineral nutrition, the results of a research aimed at comparing different strategies for evaluating plant nutritional status (leaf analysis and quick tests) and two methods for interpreting plant analysis results (an univariate and a bivariate approach), on wine grape, are reported.

On leaf samples collected at two phenological stages (fruit setting and veraison) on a previously illustrated experimental trial (Stellacci et al., 2007), SPAD readings were carried out. Moreover, on the same tissues, after drying, macro and meso-nutrients were analytically determined. For the interpretation of plant analysis results, sufficiency ranges and critical values were derived from literature, while DRIS method was applied using the norms developed from Schaller et al. (1995).

N, P and K leaf concentrations decreased during the crop cycle (from average values of 3.76, 0.30, 0.72 to 2.28, 0.126, 0.50 g100g$^{-1}$ d.m.), while Ca content showed an increment (from 2.74 to 3.15 g100g$^{-1}$ d.m.). At veraison, N and P contents were inversely proportional to Mg (and Ca) concentrations.

Between the two strategies for evaluating plant nutritional status, the quick test resulted efficacious. SPAD values were correlated to soil chemical parameters at both sampling times.

As regards the interpretation of leaf analysis results, sufficiency ranges and critical values considered were in agreement, except for K, in classifying the plants of all areas as in "good conditions“. DRIS method, taking into account the relationships among macro and meso-elements in the tissues, was instead able in underlining differences in the plant nutritional status, mainly due to a Ca and Mg imbalance. Anyway, it should be found an absolute way to interpret its results, transforming the data in fertiliser recommendations.

**Keywords:** DRIS approach, grapevine, leaf diagnosis


EVALUATION OF THE AMERICAN CRANBERRY NUTRIENT STATUS IN LATVIA DURING 2001-2007

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The commercial cultivation of American cranberry (Vaccinium macrocarpon Ait.) is one of the youngest branches of agriculture in Latvia with high potential in country’s economical and ecological future. Vast high bog territories after peat extraction, sufficient water supply, and appropriate climate provide the entire cranberry growing conditions. Today with more than 100 ha of commercial plantings Latvia is fourth major cranberries producing country. Being a native wetland plant, cranberry is nutrients low requiring culture; however balanced and precise mineral nutrition is vitally essential in producing high and qualitative yield. Investigations were done to find out the actual status and main tendencies in mineral nutrition of American cranberries in Latvia during 2001-2007. Together 160 (peat and plant) samples were collected from different cranberry producing sites in Latvia over two periods: from 2001 to 2004 and 2005 to 2007. Plant tissue analysis and soil testing were used to evaluate the cranberry supply with all of the biogenous elements (N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu, Mo, B). The results obtained revealed serious disbalance in the system of plant mineral nutrition. Insufficient level of N, P, S, Fe, Cu, Mo and increased concentration of Mn as main problems were stated. In general, positive tendencies in nutrient status of cranberries were found. Our results suggest that indices in optimal range increased from 20 % (2001-2004) to 50% (2005-2007). Lack of seriously increased nutrient concentrations in peat samples approves cranberry fertilization practices in Latvia as environmental protective.

Keywords: complex diagnostics, cranberry, nutrients
ZINC SOURCES FOR FEEDING THE ORANGE TREE NEW FLUXES

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There are three Zinc (Zn) sources for feeding the new branches of the growing orange trees: the Zn within the old parts of the tree; Zn absorbed from soil; and Zn from fertilizer applied on leaves. The objective was to quantify the contribution of each one of these Zn sources for feeding the branches of new growing fluxes of orange tree ‘Valencia’ variety. First experiment: young orange trees were grown in plastic pots with complete nutrient solution (10 L⁻¹, 0.118 mg L⁻¹ of Zn) where ^{65}\text{ZnCl}_2 (506 dpm µg⁻¹ of Zn) was added. Second experiment: five years old orange trees were grown in pots with Arenosol, and 680 mg of Zn (^{65}\text{ZnSO}_4\cdot 7\text{H}_2\text{O}, 3.7 dpm µg⁻¹ of Zn) were applied in soil surface. Third experiment: Five years old orange trees, grown in substrate, were sprayed with 80 mL/tree of a solution containing ^{65}\text{ZnCl}_2 (60 dpm µg⁻¹ of Zn) when they were emitting flower fluxes. The fluxes emitted after ^{65}\text{Zn} application were harvested when they were completely developed. In the dry mass of harvested material, ^{65}\text{Zn} was counted in a solid scintillation (NaI) and total Zn determined in AAS. Around 20% of Zn within in the old part of orange tree was distributed to the new parts (flower flux). The Zn applied to soil surface increased the Zn content of the new organs grown at least of two new fluxes; however the contribution of foliar fertilization was inexpressive for the Zn content of the organs developed after the spraying.

Keyword: citrus, distribution, fertilization, new flux
RELATIONSHIP BETWEEN IRON CHLOROSIS IN GRAPEVINE AND NUTRIENT CONCENTRATION IN FLOWER

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Experiments in vineyards affected by iron chlorosis were established in three different areas with Denomination of Origin (Condado de Huelva, Montilla–Moriles and Jerez). The fields differed in soil properties, climate, rootstock and variety. The objective of this work was to test if flower analysis could be used to determine iron chlorosis in vines. The index of chlorophyll content in leaves (SPAD) was measured at full bloom, veraison and harvest. Iron concentration in flower was correlated with SPAD at full bloom ($r=0.61, P=0.02$) in Condado de Huelva, at harvest ($r=0.39, P=0.03$) in Montilla-Moriles and at veraison ($r=0.38, P=0.16$) in Jerez vineyards. Manganese concentration in flower was negatively correlated with SPAD at veraison ($r=-0.51, P=0.06$) in Condado de Huelva, at harvest ($r=-0.26, P=0.16$) in Montilla-Moriles and at veraison ($r=-0.40, P=0.14$) in Jerez vineyards. The Mg/Zn ratio in flower was negatively correlated with SPAD at harvest ($r=-0.64, P=0.01$) in Condado de Huelva and at harvest ($r=-0.46, P=0.01$) in Montilla-Moriles. These results suggest more work is needed before flowers can be used to predict iron chlorosis in grapevine.
FURTHER INVESTIGATIONS ON THE MINERAL UPTAKE OF SWEET CHERRY ORCHARD

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Following a previous work related to macro elements, the quantity of micro elements uptake from the soil in a sweet cherry orchard, were determined for the following 9 varieties: Bigarreau Burlat, Bigarreau Moreau, Colafemmina, Denissens, Drogans, Ferrovia, Montagnola, Stark Glorious Gold and Stella.

For each variety the dry matter of fruit yielding, vegetal material from winter and summer pruning, and leaves at the fall, were weighted. Samples of each of them were analyzed to determined their contents in Fe, Mn, Zn, Cu and Boron.

By calculation it was possible to obtain the quantity of micro elements the cherry plant uptakes annually from the soil to produce a given quantity of fresh fruit. These data could be useful for the growers to obtain practical indications for orchard fertilization.
EVALUATION OF THE NUTRITIONAL STATUS OF PEACH ORCHARDS IN THE PORTUGUESE REGION OF BEIRA INTERIOR: I - ESTABLISHMENT OF THE MOST SUITABLE SAMPLING DATE FOR LEAF ANALYSIS

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Peach orchards located at the Portuguese Region of Beira Interior represent 25% of the national area of peach production. In this region a large diversity of cultivars is installed, including early-season and late-season cultivars with a high variability of yields. They are also installed on different kind of soils and are submitted to different management practices, suggesting the occurrence of nutritional unbalances. However, the available reference values for the interpretation of leaf analysis are reported, mainly, to leaf samples collected from July to August, independently of the harvesting time. In case of early-season cultivars, the results are frequently obtained after fruit harvesting and the opposite may occur with late-season cultivars whose fruits may be picked until September. The aim of present study is to contribute for the establishment of the best date for collecting leaf samples of two peach cultivars. For that purpose a survey was established including seven peach orchards (Prunus persicae (L.) Batsch), being four orchards of the cultivar O’Henry/ GF 305 and three of the cultivar Rich Lady/Monclar, respectively during three and four years. For that survey leaves were collected from 15 trees, randomly selected at each commercial orchard, being the yield controlled by tree. The leaves were sampled at three times: 50-60 days after full bloom, 15 to 30 days before harvesting and 20 to 30 days after this period. Leaf analysis results (N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu and B) corresponding to the trees with higher yields and reported to the above referred collecting dates are presented.

Keywords: leaf analysis, macro and micronutrients, Prunus persicae, yield
EVALUATION OF THE NUTRITIONAL STATUS OF SWEET CHERRY CV. SACO ORCHARDS IN THE PORTUGUESES REGION OF COVA DA BEIRA: I - ESTABLISHEMENT OF THE MOST SUITABLE SAMPLING DATE FOR LEAF ANALYSIS

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Leaf analysis is the main diagnostic test to evaluate the nutritional status of fruit orchards. Regarding sweet cherry, reference values for leaf analysis interpretation have been mainly established for leaf samples collected from July to August, after fruit collection, although some authors refer that the most suitable date is before fruit collection. In Portugal, Cova da Beira is the main producing Region of sweet cherry, being the cultivar Saco an important traditional cultivar. Fruits are collected on June and the most suitable date for leaf analysis is not yet established for the region. This work aims to give a first contribution in order to establish the best leaf sampling date, in order to diagnose the nutritional status of sweet cherry orchards, cv. Saco in the Region of Cova da Beira. With that purpose, six orchards were under survey, from 2004 to 2006: 15 trees were randomly selected at each one of the orchards and fifteen leaf samples were annually collected at each orchard. Leafs were collected from the mid third of annual shots at two different phenological stages: 59 to 67 days after full bloom, corresponding to 7 to 15 days before harvesting, and 100 to 110 days after full bloom, corresponding to 20 or 30 days after harvesting date. The yield of each tree was also evaluated, and leaf analysis was performed regarding N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu and B. Leaf analysis results corresponding to the trees with higher yields and reported to the above referred collecting dates are presented.

Keywords: leaf analysis, macro and micronutrients, Prunus avium, yield
PRELIMINARY REFERENCE VALUES FOR LEAF-ANALYSIS OF *VITIS VINIFERA* CV. TRINCADEIRA/R99 IN PORTUGUESE REGION OF BORBA

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Leaf analysis is an important tool to evaluated the nutritional status of the crops. The evaluation of the nutritional status of the majority of the crops generally involves a comparison of the foliar nutrient levels with reference values associated with specific levels of the crop performance, particularly yield and its quality. The Portuguese region of Borba is one of the main producing quality wines in the country. However, references values for the leaf-mineral composition are unknown for regional varieties. This study reports a first set of results of an experiment conducted in thirty vineyards cv. Trincadeira/R99 on Borba. In each vineyard an experimental plot with forty plants was selected. During four years (2004 a 2007), in each plot, the basal cluster opposite leaf of the grapevines was collected at full bloom and N, P, K, Ca, Mg, S, Na, Fe, Mn, Zn, Cu and B were determined in petiole. The grape yield and must quality was also evaluated. Preliminary interpretative indices were established based on the best vineyard yields of Trincadeira.

**Keywords:** leaf analysis, petioles, Trincadeira, *vitis vinifera*, yield
VEGETATIVE AND PRODUCTIVE INCOME OF SIX PEACH ROOTSTOCKS GROWING ON LIME SOIL

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In order to evaluate the vegetative and productive behavior of several peach rootstocks (Nemaguard, Atlas, MRS 2/5, Cadaman, GF 677 and GN-15, all grafted with Ruby Diamond nectarine) growing in a calcareous soil, a test was carried out for three years (2001-2004), growing the plants in 50 litre containers filled with a lime soil (6% of calcium carbonate), sandy loam textured, pH 8.0 and with a low level of available iron (5 mg/kg of Fe²⁺).

As for vegetative growth, the accumulated increase of trunk diameter (from beginning to end of test) was better in GF 677 (26.4 mm), concerning the lowest amount to Atlas (8.8 mm), meanwhile Nemaguard (17.1 mm) was average and different for both. In canopy height the highest results were for Cadaman (180.8 cm) and Atlas rootstocks (169.1 cm), similar to Nemaguard (161.7 cm) but different from GN-15 (126.7 cm). With regard to pruning weight (a vegetative expression), Cadaman (525 g) was similar to Atlas (445 g) but significantly higher than Nemaguard (325 g), GN-15 (225 g), GF 677 (220 g) and MRS 2/5 (127 g), the latter showing the least vigour expression of all rootstocks.

In the third year (first harvest of Ruby Diamond nectarine), fruit yield per plant was higher in Atlas (3.7 kg) and Cadaman (3.6 kg), in Nemaguard was average (3.2 kg) and the lowest one belonged to MRS 2/5 (2.1 kg). Regarding individual fruit weight, MRS 2/5 (97 g) and GN 15 (74 g) were better than all others, mainly compared with Cadaman (55 g). As for the number of fruits per plant, Atlas and Cadaman reached the highest figures (705 y 788) with respect to Nemaguard (588).

With respect to leaf iron chlorosis, the most severe synthomatology was shown by Nemaguard (12 mg/kg of Fe²⁺). In Atlas (19 mg/kg of Fe²⁺) leaf chlorosis was slight and in the rest of rootstocks was almost not apparent, mainly in GF 677 (26 mg/kg of Fe²⁺). All rootstocks, specially GF 677 (42.6 of SPAD instrument measure) showed a better agronomic behaviour than Nemaguard (21.6 SPAD) concerning iron chlorosis and apparently increased their leaf chlorophyll content.

Keywords: calcareous soil, iron chlorosis, lime soil, peach rootstocks
SEASONAL PATTERN OF ACCUMULATION OF NUTRIENTS BY KIWIFRUIT CV HAYWARD IN ACID SOILS OF NORTHERN PORTUGAL

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Kiwifruit production at Spain and Portugal is mainly developed on acid soils, where calcium supply to the fruits can be limited. And, it is well established that this nutrient is of upmost importance on fruit quality. In fact, several studies are carried out elsewhere in order to improve calcium nutrition. The aim of this work is to record the changes in concentration, distribution and quantity of macronutrients in leaves and fruits and to report the effects of foliar fertilization in a high-producing orchard representative of acid soils. The experience was conducted in Portugal on mature kiwifruit plants trained to Pergola system, weekly fertirrigated and alternatively supplied with foliar fertilization. The leaves and fruits analyzed for mineral concentration of nitrogen, potassium, calcium, magnesium and phosphorus were sampled respectively four times and eight times from the fruit set up to harvest. Fresh and dry weight accumulation was recorded at the same time. Nitrogen and potassium accumulated by the fruit increased linearly through the growing season whereas the rate of calcium accumulation showed a sigmoidal pattern, reaching the maximum ten weeks after fruit set. There was a positive response to fertilization on leaf concentration of potassium, calcium, magnesium and dry weight accumulation but a negative relationship with nitrogen concentration. This direct relationship was maintained for fruit N and K, whereas Ca and Mg was inversely related to foliar application. It seems that the more vigorous growth induced by additional fertilization shortened the calcium supply to fruit. And the significance of the first weeks of fruit development on final calcium accumulation is clearly stated in this study.

Keywords: acid soils, actinidia delicosa, calcium supply, mineral nutrition
THE POSSIBILITY OF USING INFLORESCENCE ANALYSIS TO EVALUATE THE NUTRITIONAL STATUS OF OLIVE TREES

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The main objective of this work was to evaluate if inflorescence analysis can be considered as an alternative to foliar diagnosis in determining the nutritional status of olive orchards. Olive leaves from cv. Arbequina, planted under high density planting system in two different sites (Tunisia and Spain), were sampled at 5 developmental stages (inflorescence emergence, fruit set, pit hardening, fruit development and fruit maturity) during two years, 2006 and 2007. Inflorescence samples were taken at the stage denominated inflorescence emergence, when the corolla changes from green to white color. Results showed that no significant correlations were obtained between inflorescence and leaf analysis for N, P, K, Ca and Mg for each site in both years. When ignoring the site of experimentation, some significant correlations were obtained between leaves and inflorescence during both years of experimentation. However, correlations were not repeated in both years. At the pit hardening stage, which coincides with the standard date for leaf sampling, significant correlations between leaves and inflorescence were obtained for N (r=-0.827**) in 2006 and for N (r=-0.604*), K (r=-0.527*), P (r=-0.760**) and Ca (r=-0.824**) in 2007. Further work is required to assess the possibility of using inflorescence analysis to diagnose the nutritional status of olive trees.

Keywords: flower analysis, nutritional status, olive trees

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AN INVESTIGATION EFFECT OF OPTIMUM BALANCED FERTILIZATION ON PREVENTING NUT DROPPING AND FLOWER PRODUCTION PERCENT IN TWO HAZELNUT CULTIVARS IN QAZVIN REGION

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An experiment “investigation effects of optimum fertilizer applying management on preventing nut dropping and flower production percent in two hazelnut cultivars in Qazvin” was carried out to evaluate the effect of some more and micro nutrients on physiology and pomology characteristics of hazelnut cultivars at Qazvin agriculture and natural resources research center. In this study hazelnut cultivars include tow Qazvin common cultivars, Hazelnut Shah and Anbouhi. A complete randomized block experiment with seven treatment including T1: control, T2: NPK + Zn, T3: NPK + , T4: NPK + Zn + B, T5: NPK + Zn with twice Zn foliar application, T6: NPK + B with twice B foliar application and T7: NPK + Zn + B with twice Zn + B foliar application, with three replication in 2002 for three years was carried out for this test. Each treatment was studied on three trees.

The results of one year showed that fertilizer application was significant incluced (p = 0.05) emptiness percentage. Lowest emptiness percentage rate of %0.2 was obtained with T7 in compared to control (%2.7). Effect of fertilizer and cultivar was significantly increased fruit weight (p = 0.01), fruit length (p = 0.05), fruit diameter (p = 0.01), nut weight (p = 0.05). Therefor, the highest fruit weight rate of 3.016 gr. Came with Hazelnut Shah cultivar and T2. Application fertilizer treatment did not significantly effect on fruit protein. The highest protein percentage rate of 14.05% came with T6 in compared to control (%1.13).

Keywords: cultivar, fertilizer, flower percentage, fruit set, hazelnut
SWEET CHERRY LEAF COMPOSITION AS INFLUENCED BY GENOTYPE, ROOTSTOCK AND ORCHARD MANAGEMENT

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In one of the most important Italian area for sweet cherry cultivation (Vignola), orchards with conventional and organic management were considered. In both of them leaf diagnostic was applied to 3 varieties (Burlat C1, Cristalina e Giorgia) grafted on 2 different rootstocks (Colt and Maxma 14). Generally speaking, the mineral elements levels are adequate for K, Mg and Copper, high for P, Ca and Boron and scarce for N, Fe, Mn and Zinc. The influence of genotype, rootstock and orchard management are discussed. The results shown that the differences in the mineral elements composition were influenced especially by rootstock and genotype, whilst the management didn’t have a strong influence.
ZINC NUTRITION IN ‘NAGPUR’ MANDARIN (CITRUS RETICULATA BLANCO) ON HAPLUSTERT

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Zinc is the most prevalent nutritional disorder in citrus orchards worldover. The management strategy of Zn deficiency, even today is governed by the efficacy of two conventionally used methods of Zn supply to plants via soil or foliar fertilization. A field experiment with 12-yr-old ‘Nagpur’ mandarin (Citrus reticulata Blanco) orchard was, therefore, carried out during 2004-07 comparing soil application versus foliar application of Zn, each at three levels viz., 100, 200 and 300 g tree⁻¹ with constant doses of N (600 g tree⁻¹), P( 200 g tree⁻¹), K (300 g tree⁻¹), and Fe( 60 g tree⁻¹) on Haplustert soil type with reference to response on flowering intensity, fruit set, tree volume, fruit yield, changes in soil fertility/leaf nutrient status, fruit quality, and transformation of native soil Zn fractions.

Soil application of Zn at all the three levels, produced significantly higher increase in tree volume over foliar application on equivalent rates viz., T₁ (2.53 m³) vs T₄ (2.06 m³) and T₂ (4.30 m³) vs T₅ (2.23 m³). The yield determining parameters like flowering and fruit set intensity (no. m⁻¹ shoot length) were, respectively, much higher with soil applied (135.74 and 21.90) than foliar applied Zn (31.20 and 11.6) of Zn. These observations set the favorable conditions required for yield response, e.g. all the three treatments involving soil application of Zn, T₁ (32.1 kg tree⁻¹), T₂ (52.6 kg tree⁻¹), and T₃ (51.8 kg tree⁻¹) were correspondingly superior over T₄ (22.5 kg tree⁻¹), T₅ (34.3 kg tree⁻¹), and T₆ (42.1 kg tree⁻¹) as foliar application treatments. All the three major fruit quality parameters (juice, acidity, and TSS) were likewise more influenced by soil application than foliar application of Zn. Improvements in soil Zn fractions (mg kg⁻¹) viz., exchangeable Zn (0.25 - 0.60), complex-Zn (2.71 to 4.86), organically bound Zn (0.86 to 2.0), and Zn-bound to carbonates and acid soluble minerals (2.56 - 4.96) were observed in response to Zn fertilization with treatments T₁-T₃. Foliar applied Zn treatments (T₄-T₆) on the other hand, produced no such changes in any of the soil Zn fractions.

Keywords: Haplustert, ‘Nagpur’ mandarin, transformation, Zn fertilization
EVOLUTION OF INTEGRATED FRUITS PRODUCTION AND THE IMPACT ON LOW INPUTS AND ENVIRONMENTAL, OF SOME TREE SPECIES IN THE SOUTH – EAST AREA OF ROMANIA

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The fruit growers of entire world are concerned with obtained ecological products the environmental production and reduction of the production cost. Research Development Station for Fruit Tree Growing Baneasa Bucharest is situated in south – east area of Romania, and it is well known at national and international level as a fruit – growing producer, specially peach and apricot. In the classical technology of peach and apricot is used a lot of pesticides (fungicides, insecticides, fertilizers). But, the use of pesticides in excess, has a negative impact on environment, the health of the consumers and the production inputs are high. In this context (the economical and ecological impact), to Research Baneasa, the studies were effectuated concerning the modern technology in apricot and peach – trees cultivation. In this work, results are presented regarding the reduction of inputs, the environmental protection and of the consumer health, applying the integrate technologies. In this system, growers use: resistance / tolerance cultivars at diseases and pests; the treatments will be applied preventive by the prognoses model; will be use of high efficiently pesticides in the photogenic agents control and reduced toxicity for man and animals.
SESSION 04
NUTRITIONAL IMPLICATIONS OF ORGANIC MANAGEMENT
The most distinctive features of tree mineral nutrition, and especially of nitrogen (N) management, in fruit tree organic farming is related to the concepts that growers should enhance the fertility of soil in order to fulfill tree requirements. In such a system, there is less space for soluble fertilizers, immediately available for trees. As a matter of fact, a significant part of highly soluble mineral fertilizers are not allowed in organic farming.

**Organic matter.** The main purposes of the organic fertilization are to enhance soil biological activity, humus level and soil structure. These objectives can be achieved by increasing soil organic matter (OM), through the use of: 1. raw or stabilized manures, 2. compost (the product resulting from the controlled biological decomposition of organic material), 3. understorey grass, 4. mulches, 5. abscised leaves, 6. pruned wood, etc. Fresh OM, such as raw manure (animal and green), cover crop, mulch, etc. with a carbon (C):N ratio < 20 should be tilled into the soil to achieve a net release of N. If OM with a C:N ratio > 20 is incorporated into the soil, microbes use available soil N to break down organic residues and a soil N depletion and a temporary N deficiencies for plant growth might be observed. However, in this case (i.e. green manure of mature cereals) an increase in soil humus is expected. Attention must be payed when fresh OM is incorporated into the soil because the composting process requires oxygen and it may create anoxia conditions.

**Nitrogen.** When nutrients are supplied in organic forms a question arises about their availability for plant uptake, so that it is difficult to predict when a nutrient is released for plant uptake. This issue is critical especially for N, because of its mobility through the soil profile that can easily lead to water pollution. In addition, the organic growers tend to intensify the rate of N application in the attempt to increase fruit yields to the level typical of integrated fruit management. In case of temporary N deficiencies (lack of synchrony between N mineralized from organic matter and tree N uptake), applications of fertilizers with a short release time and an effect similar to mineral compounds can be recommended. Among these fertilizers are: blood meal (N = 5-12%), fish meal (N 5%), natural guano (N = 16%), poultry manure (N = 3.7%). Among fertilizers with slow N release rate, stabilized manure and municipal solid waste (MSW) compost allow a complete ‘nutrient cycling’ (the breakdown of organic substances, release of energy and matter captured by life processes and their use to stimulate the new growth). In addition, by incorporating MSW composts into the soil there is a sequestration of C that otherwise would follow disposal processes which potentially release CO₂ in the atmosphere. In a 7-year-long trial, yearly application of 10 t/ha of compost made of MSW mixed with pruning material from urban ornamental trees and waste material from agro-industry processes, after a 3-month stabilization, increased soil OM content (from 1.6 to 3%) with no effects on nitrate-N concentration (Baldi et al., 2006). Meat meal, cow manure, bone meal have a very slow N mineralization rate (Gaskell et al., 2007).

**Phosphorus, potassium, calcium and magnesium.** Rock powders can be used to restore and balance soil reserves of tree nutrients, although they are not very soluble and consequently ineffective for
overcoming short term nutrient deficiencies. Sources of P are: hard rock phosphate (about 2% of P$_2$O$_5$), soft or colloidal rock phosphate (3% of P$_2$O$_5$), bone meal (40% of P$_2$O$_5$). Potassium can be supplied by granite dust or greensand (which have a very slow mineralization rate) or by wood ashes especially in acid soils (where they may rise soil pH). Calcium-based products available for soil supply in organic management are gypsum (CaSO$_4$$\cdot$2H$_2$O), and lime (Ca carbonates), that are characterized by a limited solubility and availability for plants, consequently Ca fertility must be built up before tree plantation. Calcium chloride, with certain restrictions, can be used for apple foliar applications. Limestone (a source of Ca and Mg) and dolomitic lime (Mg) are recommended in acid to sub-acid soils because they rise the soil pH. The marine evaporate deposit langbeinite (K$_2$Mg(SO$_4$)$_3$) and epsom salts (MgSO$_4$ 7H$_2$O) are sources of Mg, the latter can also be sprayed.

**Micronutrients.** The soil availability of trace elements is usually increased by application of OM. Iron management of fruit trees is a major issue in calcareous soil, where prevention of leaf chlorosis might be achieved by appropriate agronomic techniques that include: introduction of resistant or tolerant rootstocks, increase in OM soil content, floor management with graminaceous such as *Festuca* spp. that are known to produce phytosiderophore (Ma et al., 2003) compounds (i.e. mugineic acid, a natural Fe chelators), use of blood meal that contains the Fe chelator heme group. Legislation of some Countries (i.e. Italy) allows, under certain conditions, the controlled use of synthetic Fe-chelates.

**Nutrient management and fruit quality.** The effect of organic fertilization on quality and especially on nutritional value of fruits is still debated. In comparison to integrated or conventional systems, organic fruit management was found to increase the content of phenols (flavanols) and nutritional fibers in apple (Weibel et al., 2000), α-tocopherol in pears, ascorbic and citric acids peaches, but at the same time to decrease α-tocopherol in peaches (Carbonaro et al., 2002). Stress conditions such as low N availability seems to promote the synthesis of ascorbic acid (Brandt and Mølgaard, 2001), while a decrease of the concentration of phenolic antioxidants (Mitchell and Chassy, 2007) may be expected in plants with increasing nutrient availability. From this knowledge it rises that if nutrient availability is maintained in the optimal range for the crop, no substantial difference in fruit composition should be expected in organic compared to integrated or conventional nutrient managements.

**Keywords:** C:N ratio, compost, iron chlorosis, manure, nutrient cycling, organic matter

**References:**
ORGANIC FERTILIZATION OF RED RASPBERRIES GROWN ON SOIL IN POLYETHYLENE TUNNELS

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The article covers results from two raspberry fields. One fully grown raspberry field planted in 2003, is located at Brønøysund in Norway (latitude 65°). The soil is a sandy loam with 4.5-12% organic matter and 5-10% clay. The sand is calcic with pH 7.8. The second field was planted in August 2006 so the primocane growth was delayed to 2007. The field is located at Harstad (latitude 68°) on a mineral soil high in organic matter (20-40%) with less than 5% clay and a with pH 5.7. Both fields are situated at the north-Atlantic coast and are produced organic. The challenge is to find fertilizers certified for organic production and to combine these to optimize plant growth, fruit yield and quality. In Norway there are few registered fertilizers on the market certified for organic production and those which exist, are produced by small and vulnerable industries. An experiment using combinations of the dry fertilizers Agromarin®, Marihøne® (chicken manure) and Marihøne+® (88% milled bone plus vinasse, a rest product of yeast) and the multi nutrient fluid fertilizer Oase®, was performed in the summer 2007. This article will present the results and a discussion of how to balance the nutrients.
REDUCTION OF BORON UPTAKE BY NITRATE, SULFATE AND SOLUBLE ORGANIC MATTER IN CITRUS

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Boron is a toxic element that is present in sewage effluent reused for crop irrigation. On the other hand, citrus can benefit from both the nutrients present in the reclaim water and source for irrigation in arid zones. Based on evidence in the literature of antagonistic effects between some elements and boron uptake, we searched for effective options to decrease boron uptake by the trees. During the summer of 2005, citrus seedling (3-6 months old) were grown in the greenhouse in adequately aerated 10-l nutrient solutions with different combinations of boron (0.3 – 12.0 mg l⁻¹), nitrate (2.5 – 41.0 mM), sulfate (0.5 – 6.0 mM), and soluble organic matter (14 – 53 mg l⁻¹ carbon). Each combination was tested for 28 days growing period, during which the solutions were monitored twice a week. At the end of each cycle, the plants were excised into their parts, each of which was sampled and analyzed. Water uptake by the seedlings was similar in all the treatments within each experiment (280 - 400 ml day⁻¹). Boron concentration in the leaves linearly responded to boron concentration in the nutrient solution. Sulfate had no affect on boron concentration in the leaves while soluble organic matter somewhat reduced it. The organic matter did however substantially decrease boron concentrations in young roots. Nitrate, at 20 – 41mM, reduced boron concentrations in the leaves. Nitrate concentrations in young roots were several folds higher then in the leaves. Nitrate effect on boron uptake is now being tested in more mature trees that are grown in lysimeters.

Keywords: boron, citrus, nitrate, organic matter, sulfate
COMPARISON BETWEEN ORGANICALLY AND CONVENTIONALLY MANAGED IN SEVERAL CITRUS ORCHARDS IN THE EASTERN SICILY

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Recently organically managed citrus crop farming has become more and more common in the Mediterranean basin as a result of increasing consumer demand.
A study on soil fertility and plants-yield nutritional status in organically and conventionally managed citrus orchards was carried out using a field survey approach to optimize organic fertilization on citrus cultivation. The work was conducted on ‘Navelina’ and ‘Tarocco’ orange \textit{[Citrus sinensis (L.) Osbeck]} in Sicily. Fifty-four farms (twenty seven conventionally and twenty seven organically managed), similar for environmental-cultural conditions and site characteristics (age, type and rootstock), were chosen in order to reduce the effects not directly linked to the different fertilization management. Soil fertility and quality results obtained from the survey revealed changes in some chemical and biochemical parameters of the organically and conventionally managed systems. Organic matter and total nitrogen, representative of soil long-term fertility status, presented higher values in organically managed orange groves. Furthermore, biochemical parameters were tested to assess soil fertility and showed more efficient soil microbial metabolism in organic farming systems. The nutritional status of citrus trees showed optimal range of nutrients concentration. There were only slight differences in some foliar nutritional levels (P, K, Fe), which may be due to the different methods of fertilization. No significant differences in yield were observed between the organically and conventionally managed farms. Assessment of fruit quality parameters revealed significant differences in vitamin C content, this being highest in organic ‘Navelina’ orange. On the contrary, anthocyanins content was lower in organic ‘Tarocco’ orange.

\textbf{Keywords:} fruits quality, management, plants yield, soil fertility
INTEGRATED NUTRIENT MANAGEMENT FOR BETTER QUALITY AND YIELD OF KINNOW MANDARIN

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In Pakistan, Kinnow mandarin (Citrus reticulate Blanco) has gained popularity due to its quality, high productivity and higher returns. This is the main reason that out of the total citrus production of country, share of Kinnow mandarin is more than 90%. With the increase in awareness of consumer about health and organic fruit production, application of plant with inorganic nutrition does not guarantee better fruit quality. Now, consumer demands citrus fruit free from hazardous residues. In such scenario, supply of organic nutrients through soil reserves might be the first preference for citrus grower, but unfortunately, soils of Pakistan have very limited organic matters (<2%). So, integrated nutrient management is a step towards sustainable citrus production. This study was carried out to determine the integrated effect of organic matter alone and in combination with chemical fertilizers in order to maintain the nutritional status in Kinnow fruit plants. Research experiment was conducted at Institute of Horticultural Sciences, University of Agriculture Faisalabad. Lahore Compost® was used as source of organic matter. Treatments were made by using compost alone and in combination with NPK (Engro Chemical Ltd. Pakistan) and well rotten FYM (cow dung). Treatments were applied before flowering and after fruit set. Effect of these treatments on different Physico-chemical characteristics of Kinnow fruit and nutritional status in tree leaves was determined. Among all treatments minimum flower drop, maximum yield and better fruit quality were recorded in plants where 40kg compost + ½ recommended doses of NPK were applied before flowering and after fruit setting while, minimum fruit set was recorded plants where 30kg compost alone was applied before flowering.
THE IMPACT OF OLIVE-MILL WASTEWATERS ON PHYSIOLOGY AND NUTRITIONAL VALUE OF PEAS

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We investigated the effects of two olive-mill wastewaters (OMW) dilutions (1:20 and 1:10) on one month-old peas (Pisum sativum L.) grown in soil under greenhouse conditions, with respect to plant growth, physiology, nutrient uptake, fruit quality and nutritional value. The exposure to 1:10 OMW for one-month period, led to significant decreases in shoot biomass (by 33% of control) and leaf area (by 34% of control). Plants treated with 1:10 OMW dilution revealed nutrient deficiency symptoms, since the uptake and translocation of Ca, Fe, Mg and K were impeded. The vitality index (Rfd) of the leaves under OMW application was significantly suppressed and the photosynthetic pigments were decreased, while the proportion of the light absorbed by the chlorophylls associated with PSII that is used in photochemistry (ΦPSII) was highly reduced, showing functional disturbances. Photosynthesis was seriously inhibited by OMW. The strongly limited photosynthetic rate (PN) (76% of the control) might be due to reduced stomatal aperture. The significantly suppressed water use efficiency (WUE) indicates the provocation of water stress by OMW application. Despite the OMW toxicity on peas plants, fruit production was achieved. Fruits of control plants were fresh, well formed with bright green color, while those of OMW were fewer, smaller in size and discolored. OMW decreased glucose and fructose concentration, while the glucose/fructose ratio increased significantly (2 fold), indicating that fruits produced under OMW application were immature. In addition the loss of ascorbic acid (by 50%) and the enhancement of phenol concentration indicates their poor nutritional value.

Keywords: ascorbic acid, nutrient status, olive mill wastewaters, photosynthesis
POTENTIAL OF ANIMAL MANURES TO IMPROVE SOIL CHEMISTRY AND TO SUPPLY NUTRIENT REQUIREMENTS OF THE 8-YEAR-OLD APPLE (CV. GOLDEN DELICIOUS)

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Improving soil fertility including soil nutrient retention capacity, water holding capacity, and C/N ratio are very important for the some apple orchards where have been established in sandy and infertile soils in the province of Zanjan, Iran. Application of cow manure (15 and 30 t ha⁻¹) and poultry manure (5 and 10 t ha⁻¹) to the soil surface and mixed to 30 cm depth as soil amendments increased significantly (P = 0.05) soil organic matter (OM), soil EC, soil pH, and CEC. There was a positive relationship between amounts of manure applied and soil OM contents. The poultry manure (10 t ha⁻¹) treatment gave higher levels of soil element contains (K, Mg, Ca and N-NH₄⁺) and soil EC. Poultry deep manure contained approximately moisture 55.5%, organic matter 26%, ash 15%, N 2.4 %, Ca 2.5%, P 1.6%, Na 0.5%, K 2.40%. It generated up to 2 to 3 times increase in soil K and significantly increased petiole K, over the two year period of the experiment. There was not observed any symptoms of mineral deficiencies in all treatments during growth seasons. However, the highest apple yield (36.7 t ha⁻¹) was obtained in the control treatment (integrated fruit production, IFP).

Keywords: M. pumila, nutrition, organic apple orchard, soil amendment, soil organic matter
It was evaluated the response of citrus tree (*Citrus sinensis* Osbeck), cultivar ‘Newhall’, to the application of three organic compounds and two mineral fertilizers. Treatments with the application of mineral fertilizers were carried out using a N:P:K conventional fertilizer (FSK) and a controlled release fertilizer (ALC). The application of organic waste and organic compounds was conducted with the use of sewage sludge (LU), pulp-mill sludge (LC) and a commercial organic compound with the name of Guano Sansão (SA). In the first year, the following parameters were evaluated: increases of tree height and trunk diameter, foliar nutrients content, concentration of nitrate in leachates and several soil chemical parameters. In the 2nd year, these parameters were also evaluated. Crop yield were recorded and it was evaluated some parameters concerning fruit quality.

In the 1st year, FSK treatment showed the largest increases in tree height and trunk diameter parameters. In the 2nd year, the largest increases in tree height and trunk diameter were observed with the LC treatment. Trees where ALC were applied showed normal values of nitrogen leaf concentration; the other trees had values below the optimum.

Leachates from the ALC treatment showed the highest nitrate concentration. Nitrate concentration was higher in early autumn, decreasing by the middle of the winter.

The fruit production and the number of fruit per tree were not statistically affected by the material fertilizer applied. Concerning fruit juice quantity and quality, there were no significant differences in juice percentage (m/m), or in the concentration of soluble solids (° Brix).

**Keywords:** controlled-released fertilizer, fruit quality, nitrate leaching, pulp-mill sludge, sewage sludge
AGRONOMICAL UTILIZATION OF CAROB SEED RESIDUES

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It was evaluated the agronomical use of carob seed residues obtained at the Danisco Portugal, as an organic amendment and/or as a substrate in a tomato (Lycopersicum esculentum L.) crop, cultivar “realeza”.

Plants were grown in several treatments of soil and carob seed residues mixtures, in order to evaluate their response to the increasing amount of carob seed residues mixed with a sandy topsoil. During the experiment it was registered, on a weekly basis, several biometrical parameters related to the plant development, as the plant height, and the number of leaves, inflorescences and ripe fruits. Regarding production, fruits were individually weight and measured the transversal end longitudinal diameter sections.

Soil, carob residues and soil and carob residues mixtures were chemically analysed, to determine the following parameters: organic matter content, pH, electrical conductivity, N, P, K, Ca, Mg, Fe, Mn, Zn, Cu, Cd, Cr, Ni and Pb contents. Cu, Cd, Ni and Pb were only determined in the carob residues before mixing with the sandy soil.

The experimental results showed that it was not possible to point out very exactly which of the different treatments was the best. Nevertheless, by the end of the experiment, it was seen that the 100% carob residues (used as an organic substrate) was the treatment where it was observed the highest crop growth rate, with more leaves and fruits, and the greatest yield. Plants of the 100% carob residues treatment also showed a root system bigger than the other treatments.

The obtained results suggest that carob seed residues may be used as an organic amendment and/or as a substrate.

Keywords: crop production, organic amendment, organic substrate, soil/substrate nutrient content, yield
LEAF DIAGNOSTIC IN HAZELNUT ORCHARDS UNDER ORGANIC AND CONVENTIONAL MANAGEMENT

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In the Langhe district (Piedmont), the leaf diagnostic was applied in 3 different areas of hazelnut cultivation. In each of them, in very similar pedo-climatic conditions, one orchard under organic management was choose in comparison with another one under conventional management. The leaf has been sampled for 3 years (2005-2007), at the fruit harvest time. Usual chemical analysis were made to determine the level of macro and micro nutrients. Soil analysis also has been made in the last 2 years but they aren’t so different between orchard with different management.

The data shows that orchard management doesn’t significantly influences the leaves mineral composition, while some significant differences has been observed between orchards and years. Anyway the observed leaf levels of macro and micro nutrients, with the exception of Calcium, Iron and Boron, are very low and in some cases really very poor.
NUTRITIONAL STATUS OF KIWIFRUIT USING ORGANIC VERSUS CONVENTIONAL FARMING SYSTEMS

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In today’s society there is growing concern about the environment and fruit quality. Hence, agricultural practices should adapt to these new demands, by using new farming management systems that are less aggressive with the environment yet that allow improved production and fruit quality. The kiwifruit (Actinidia deliciosa (A. Chev.) C.F. Liang et A.R. Ferguson) is a crop of great commercial interest. Although the consumption of this fruit has only been recent, it is rapidly becoming widespread in our households. In Galicia (NW Spain), the region showing the highest production of kiwifruit in Spain, different management systems are used, among them being conventional and organic. Thus, the objective of this study was to compare the nutritional status of the plants and the quality of the fruits produced using organic agricultural practices versus those of the conventional system. For this, two plots located close to each other geographically, in which different farming systems were used, were selected. Throughout the production cycle the possible effects of the management practices on the following parameters were studied: bud break index, flowering index, kinetics of fruit growth and yield. Furthermore, the evolution of the nutritional status of the soil and the plant (leaves and fruits) was also analysed. The results obtained in this study suggest that the management system used could affect the nutritional levels and growth cycle of the plant.

Keywords: Actinidia deliciosa, farming systems, fruit quality, plant analysis
SESSION 05
FERTILISATION PRACTICES AND THEIR ENVIRONMENTAL IMPACTS
FOLIAR FERTILISATION: A RELIABLE STRATEGY TO CONTROL PLANT NUTRIENT DEFICIENCIES?

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Foliar fertilisation is a common agricultural practice to control plant nutrient deficiencies and/or a complement to root applications. In theory, treatment with foliar sprays could be a cheaper, target-oriented and more environmentally friendly strategy to overcome nutrient deficiencies of fruit crops. However, variable responses to foliar treatments have been often described and foliar fertilisation cannot be currently considered a reliable alternative to control plant nutrient deficiencies. The lack of understanding of some factors relating to the penetration, distribution and bio-activity of leaf-applied, nutrient solutions hinders the development of effective foliar spray formulations. An account of the key factor involved and future perspectives of foliar fertilisation will be discussed in light of the state-of-the-art concerning foliar and cuticular uptake studies.

Keywords: foliar fertilisation, foliar penetration, foliar uptake, nutrient deficiencies

Acknowledgements: V. Fernández is on a Juan de la Cierva MEC Post-doctoral Contract, co-financed by the European Social Fund. Work of the Plant Stress Physiology Group, Plant Nutrition Department, Aula Dei Experimental Station, is supported by the Commission of European Communities (Project Isafruit) and the Spanish Ministry of Science and Education (MEC) (Projects AGL2006-01416 and AGL2007-61948, co-financed by FEDER).
EFFICACY OF HJB/Fe$^{3+}$ TO PROVIDE Fe TO NECTARINE PLANTS IN CALCAROUS SOILS

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Iron chlorosis is a widespread problem in fruit crop production grown in calcareous soils and up to date the application of synthetic iron chelates is the most effective solution to correct this problem. The aim of this work was to study the effectiveness of a new synthetic iron chelate, HJB (ethylenediamine-N,N’-di (orto- hydroxyl para-methyl phenyl)-N,N’-diacetic acid) to provide Fe to nectarine trees in alkaline field conditions. HJB presents a similar structure to o,oEDDhA but its synthesis may produce purer commercial products than the EDDHA synthesis that produces o,oEDDhA, together with a mixture of regioisomers (o,pEDDhA and p,pEDDhA)¹ and other unknown by-products².

Experiment started in 2007. Nine years old nectarine, cultivar Zephyr grafted in GF677 rootstocks were used. Two treatments with two different doses (0.45 g Fe-chelate/tree and 0.90 g Fe-chelate/tree) were assayed: a commercial EDDHA/Fe$^{3+}$ product (5.19 % Fe chelated by o,oEDDhA) and HJB/Fe$^{3+}$ (7.97% Fe chelated by HJB) and a control –Fe. The iron treatments were directly injected into the soil at three stages. SPAD index was recorded every two weeks and leaves were sampled 30, 60, 90 days after the first application of the treatments. Yield, fruit weight, number of fruits per tree and fruit calibre were also determined.

In the first year HJB/Fe$^{3+}$ and EDDHA/Fe$^{3+}$ improves SPAD results with respect to control (–Fe), however no significant differences have been found with respect to iron nutrition neither between the yield of the treated and control (–Fe) trees. Currently, a second year of experiment is being developed.

Keywords: EDDHA, HJB, iron chelates, nectarine


Acknowledgments: Financial support has been provided by PPC ADOB (Poland) and by the project AGL2007-63756 of the Spanish Ministry of Science and Education.
USING CONTROLLED RELEASE FERTILIZERS FOR PERENNIALS INCREASES PRODUCTIVITY WHILE REDUCING FERTILIZER APPLICATION RATES

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Application of controlled release fertilizers (CRF) is considerably phasing in for the mineral nutrition of annuals like arable crops, vegetables and ornamentals. The highly positive outcomes of the usage of CRF in annual crops include: lower fertilizer application rates, less field operations, less soil compaction, reduced mineral losses by percolation and volatilization and constant optimal availability of nutrients in the soil solution. Our experiments were performed on three different types of perennials in various growth conditions, to show the uniform pattern typifying all results.

The total- and kernel- yields of macadamia trees (*Macadamia hildebrandii*), grown in Australia, were increase by 33%, following N-P-K fertilizer application rates which were reduced by factors of 25-30-23 %, respectively, as compared with the commercial mineral nutrition practice.

Tea-Tree (*Melaleuca alternifolia*) fresh biomass of harvested leaves, and total essential-oils yield increased by 19%, following N-P-K fertilizer application rates which were 100-55-230 %, respectively, of the commercial mineral nutrition practice.

Tequila Agave (*Agave tequilana*, Weber) experiments with CRF products held in Jalisco, Mexico, showed the following findings:

The plots treated with the CRF evinced a continuous high level of available soil N, P and K, and optimal values of E.C. and pH, as compared with the control. A significantly higher “head” (the sugars-accumulating stem) yield coupled by a higher content and total yield of reducing sugars; better vegetative appearance, and better freezing-resistance. Again, these effects were achieved by applying considerably less mineral nutrients, in the form of CRF.

**Keywords:** blue-agave, controlled-release fertilizer, macadamia, tea-tree
EFFECTS OF NITROGEN FOLIAR SPRAYING ON NITROGEN LEAF CONTENT AND NITROGEN AND CARBOHYDRATES RESERVES OF GRAPEVINE SHOOT BUDS

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Nitrogen foliar spraying in grapevines in Southern Brazil is used to complement to soil fertilization, without any information about leaves nitrogen content and or the perennial parts reserves. The experiment was carried out in 2004/2005, with objective to evaluate the effect of nitrogen foliar spraying on leaf N content and yolks of shoots carbohydrates reserves of Chenin Blanc grapevine, grafted on 101-14 rootstock, located at Bento Gonçalves city (area of the Serra Gaúcha, 640 m altitude, in Rio Grande do Sul State, Southern Brazil). Grapevine were planted in 1986 with plant distance of 1.5 (between rows) x 2.5 (along the row) m on Udorthent soil. The climate is subtropical with rainfall annual averages 1736 mm. The treatment was three foliar spraying of nitrogen 0 (water); 1.11; 2.23; 3.31; 4.41 g N grapevine⁻¹. Leaves were picked, oven-dried and total nitrogen analyzed. In the last pick up of leaves, three shoots were picked in each plant, picked six buds, prepared and determined starch, total soluble carbohydrates, carbohydrates reducers, total amino acids and total proteins. The results showed that nitrogen content increased in the leaf and spraying of nitrogen decreased starch content and total soluble carbohydrates in shoots buds, but did not affect carbohydrates reducers and totals of amino acids and proteins.

Keywords: amino acids, foliar fertilization, starch, Vitis Vinifera
EFFECT OF POTASSIUM FOLIAR SPRAY ON ROYAL GLORY PEACH TREE

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Potassium is an essential mineral nutrient for the fruit growth and quality. Foliar sprays start to be used by fruit growers in addition with soil application.

This study was undertaken in order to evaluate the effects of potassium foliar applications as only way of fertilization on growth, yield, fruit quality and mineral status of Royal Glory peach tree. Potassium as Solupotasse has been applied by foliar sprays at (50% and 100%) of the tree requirements. The foliar sprays were split according to the various critical stages of the fruits growth.

A control without foliar spray fertilization was also observed.

The results showed that foliar spray did not have a significant effect on vegetative growth.

The two foliar sprays at 50% and 100% show an increase of fruit weight, °brix level and a decrease of fruit acidity.

No significant effect was observed on the foliar status for the different mineral elements.

Keywords: foliar spray, peach, potassium, quality
A PRELIMINARY NITROGEN BALANCE IN OLIVE ORCHARDS

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Traditionally, the enormous risk for the production of nitrogen deficiency together with the low relative cost of this type of fertilizer have led to an excessive application of this element when that deficiency was not noticed yet. This practice may cause negative effects on productivity and fruit quality. Moreover, it may cause groundwater pollution by nitrate and may interact with other elements hampering its uptake. The lack of effects on yield and vegetative growth parameters observed in olive trees that had not been fertilized with N over 10 years together with the environmental impact caused by annually applications of nitrogen motivated this work. The main objective of this study was to quantify some of the major factors involved in the N balance, understood as the difference between inputs and outputs of this element to the system, which may explain this behavior of the trees. For this purpose, an experiment with 20 years-old olive trees of the cv. Picual, non-irrigated, and spaced 7x7 m apart was carried out. A randomized completed blocks design was used. The treatment studied was the amount of N applied to the soil (0, 0.5 and 1 kg/tree). As N inputs, mineralization and rain entrance were measured and as outputs, leachate, volatilization and prune and crop extraction were determined. N removed by the crop was compensated for inputs due to mineralization of the organic matter and the N applied by the rain. These preliminary results suggest that, in some cases, the lack of effects observed may be explained for the positive result of the N balance obtained.

Keywords: fertilization, groundwater-pollution, leachate, olive, volatilization
EFFECT OF FOLIAR BORON APPLICATION ON OLIVE (OLEA EUROPAEA L.) FRUIT SET AND YIELD

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Boron is an essential plant element and its role in many physiological processes is well known. Several studies report its crucial function in improving flower fertility and fruit setting percentage in olive. Deficiencies phenomena, responsible also of suboptimal yield, are observed in olive groves and sometimes not recognised. As recent studies (Brown and Hu, 1998; Perica et al., 2002) have shown that B is mobile in the phloem of all species that utilize polyols as a primary photosynthetic metabolite, such as olive, then B deficiencies, but also hidden hungers, may be treated with foliar applications.

The aim of the present research was to evaluate the efficacy of a foliar fertiliser containing B in increasing fruit set and yield in olive.

The research was carried out in 2004 on an olive orchard, cv Leccino, located in Francavilla Fontana (BR), Southern Italy, during a bearing year. A control was compared to a B fertilised treatment that received two foliar applications with a product containing 9 g B 100g⁻¹, at 270 mg B L⁻¹, at flower cluster growing and petals falling. The experimental design was a randomised block with 4 replications. During the crop cycle, the fruit setting percentage, on 2 plants per plot and 2 shoots per cardinal direction and, at harvesting, the main quantitative and qualitative yield parameters were determined. Total number of flowers and fruits per shoot varied significantly in function of shoot length and canopy exposition. Neither fruit set nor yield were influenced by B foliar application. Average values of 4.29 and 4.65 %, for fruit set percentage, and 32.2 and 30.6 kg olive pt⁻¹, for yield, were recorded, respectively for treated and not treated plants.

Keywords: boron, foliar fertilisers, fruit set percentage, olive
EVALUATION OF THE EFFECTIVENESS OF SOIL-APPLIED MELIA (MELIA AZEDARACH L.) DERIVATIVES ON NITROGEN AVAILABILITY TO PEACH TREES

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The objective of this study was to evaluate the effect of soil applied plant derivatives of melia (Melia azedarach L.) tree on availability of N for peach nutrition. On April 2006, 40 one-year old peach trees cv ‘Rome Star’ on GF677 peach x almond hybrid were placed in 20 l pots. On May 16, 20 pots were fertilized with compost at a rate of 100 g/pot, and 20 pots were addressed with urea (1.4 g/pot). On September 11, the 2 sets of trees received the same amount of N (0.64 g/pot) as urea and blood meal (compost-treated pots). The following compounds as nitrification inhibitors were applied to 4 pots each: untreated control; 3,4-dimethylpyrazole phosphate (DMPP, 10 mg/pot); commercial neemcake (20 g kg\(^{-1}\)); ground fruits of melia at a rate of 20 and 40 g kg\(^{-1}\). All inhibitors were incorporated into the soil at planting except for DMPP, that was supplied contemporary to urea and blood meal applications. The application of neemcake increased soil NO\(_3\)\(^-\)-N, in both sampling dates. An increase in leaf N concentration and microbial respiration was observed after application of neemcake and ground melia fruits (at both concentrations), and only the latter increased shoot length. Similar results were observed in laboratory (at 25 °C) where mineralization rate of urea-N was promoted by neemcake and melia ground leaves, in comparison with soils that received urea only. Finally, to evaluate the effect of melia derivatives on root N uptake and partitioning, GF677 trees were potted in soil mixed with neemcake, melia ground leaves, and fertilized with ammonium nitrate in which both N fractions were \(^{15}\)N enriched (10% atm.). Analyses are currently in progress.

Keywords: microbial respiration, neem, nitrate, urea
AN APPROACH TOWARDS THE DETERMINATION OF THE FERTILISATION REQUIREMENTS OF THE PEAR CULTIVAR ‘ROCHA’

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The fertilizer supplied to six orchards planted with pear cultivar ‘Rocha’ which recorded a sustained, steadily increased productivity during the last 3-5 years, was analysed in order to evaluate the best amounts and proportions of the different minerals required by that cultivar. Data were collected from the records of the enterprises, all located near Cadaval (Portugal), concerning the period 2000 to 2006. Orchard areas ranged from 4.6 ha to 62 ha. The total area which was the object of this study ranged from 129 ha to 144 ha of orchards in full production. Average productivity was increased from 14.5 ton/ha during the first four years to 26 ton/ha during the last three year period. As a general rule, the amounts of nutrients supplied per unit weight of fruit produced decreased steadily with increasing productivity (with the exception of potassium), indicating a better utilisation of fertilisers and consequently a lower loss to the environment. During the last three-year period of observations, the variance of the amounts of fertilizers applied in the orchards under observation was reduced (as evaluated by the ratio of their standard error to the average calculated for each year and mineral nutrient). The average of the total amounts used in this period, and its partition as soil, fertigation and spray, are proposed as an approach to a good fertilization practice of this variety.
PROPERLY TIMED FOLIAR FERTILIZATION CAN AND SHOULD RESULT IN A YIELD BENEFIT AND NET INCREASE IN GROWER INCOME

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Foliar fertilization can reduce nutrient accumulation in soil, run-off water, surface water (streams, lakes, ocean), and groundwater (drinking water supply), where they contribute to salinity, eutrophication or nitrate contamination, with negative consequences to the environment and humans. Soil-applied fertilizers should be replaced at least in part with foliar-applied fertilizers. Foliar fertilizers meet the crop’s demand for nutrients when soil conditions (low temperature, low soil moisture, soil pH, salinity) render soil-applied fertilizers ineffective or when nutrients (e.g., phosphate, potassium and trace elements) become fixed in the soil. Foliar fertilization is an efficient method to overcome the soil’s inability to transfer nutrients to the plant. Applying nutrients directly to leaves ensures that the plant’s photosynthetic machinery is not compromised by low availability of an essential nutrient. Foliar-applied phloem mobile nutrients are translocated to all plant parts, even feeder roots. However, not all nutrients are taken up through leaves and, even if taken up, some nutrients are not phloem mobile. Foliar fertilizer rates are typically lower than soil fertilizer rates, but application can be more costly. The approach of my research program to properly time the application of foliar fertilizers to key stages of citrus and avocado tree phenology when demand for the nutrient is likely to be high has proven successful for increasing yield, fruit size or fruit quality, such that foliar fertilization results in a net increase in grower income even when the tree is NOT nutrient deficient by standard leaf analysis.

Keywords: avocado, citrus, foliar fertilization, income
FOLIAR FERTILIZATION – IS THERE A STRATEGY BEYOND “SPRAY AND PRAY”? 

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Even though foliar fertilization is a common practice to prevent or overcome nutrient deficiencies, there is still a large gap between theoretical approaches to describe and predict the processes involved in foliar penetration and field observations, where the success of foliar fertilization is frequently unpredictable. The present paper focuses on two basic parameters determining the effectiveness of foliar fertilization: First, the effective concentration of a foliar-applied compound on the leaf surface reached after equilibration with the environment, and second the permeability of the leaf surface.

It is shown how the prevailing ambient conditions (such as relative humidity, wind speed or temperature) and the deliquescence point of a given foliar-applied substance can drastically change its effective concentration on the leaf surface reached after equilibration and thus the driving force for uptake. This equilibrium concentration is independent of the initial concentration and can range from practically nil to several moles per liter. Besides the concentration of a foliar-applied substance uptake rates also strongly depend on the permeability of the leaf surface. Data are presented demonstrating that the permeabilities of both the cuticular and the stomatal pathway are highly variable and also depend on ambient conditions, particularly on relative humidity. The size exclusion limits of the foliar uptake pathways are discussed. Experimental evidence is presented that cuticular “pores” can be considerably larger than previously estimated and enable the uptake of large compounds such as Fe-chelates.

Keywords: cuticle, foliar uptake, leaf surface, stomata
FERROUS PHOSPHATE DECREASES IRON CHLOROSIS IN GRAPEVINE

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The effectiveness and long-term effect of ferrous phosphate (vivianite) applied to the soil for preventing iron chlorosis in vine was studied during three years (2003-2005) in six regions of Denomination of Origin in Spain (Rioja, Ribera del Duero, La Mancha, Montilla-Moriles, Condado de Huelva and Jerez). The vineyards differed in grapevine rootstock/variety, climate and soil properties. A suspension of 5 kg of vivianite in 100 L of water was prepared in the field by dissolving in this volume 2.5 kg of (NH₄)H₂PO₄ and 7.5 kg of FeSO₄.7H₂O. This suspension was injected into the soil at a depth of ∼45 cm in several points around the trunk at a rate of 250 g of vivianite/plant. The SPAD value of the vines fertilized with vivianite was significantly higher than those of the control (−Fe) through the three years in all the fields but the Jerez field. The trunk perimeter increment of the vines fertilised with vivianite was higher than in the control one in four experimental fields. When the effectiveness of vivianite was compared with Fe-sulphate (Rioja field) or with Fe-chelate (La Mancha field), there were not significantly differences. These results suggests that vivianite is effective and persistent in correcting Fe chlorosis in vine but with longer effect than other Fe compounds. The key of that persistence is ascribed to the presence of phosphate, which favours its transformation to poorly crystalline iron oxides, which are the main source of Fe for the roots in calcareous soils.
STUDY OF THE EFFECT OF NITROGEN FERTILIZATION SUPPLIED BY FOLIAR SPRAYS OR BY FERTIGATION IN APPLE TREES. PRELIMINARY RESULTS

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Nitrogen (N) is often the most limiting nutrient for crop growth, for which greater amounts than those required are usually applied. Previous results have shown that excess soil applied N did not cause significant changes in the level of nutrients, or in the quality of yields, but contributed to soil and water pollution. To analyze if N fertilization provided by foliar sprays effects affects growth and cropping of apple trees, a trial performed on ‘Golden Reinders’/M9 apples was designed. The experiment was performed in Alfamén (Saragossa, Spain), in the Middle Ebro Valley. The orchard fertilization was made through the drip irrigation system, adding 98 UFN. Three treatments involving N additions to the soil, (32, 130 or 170 UFN) over the fertigation scheduling, were compared with 130 UFN applied by foliar sprays. NH₄NO₃ was the N source. The results showed that no differences in fruit growth patterns in trees treated with foliar sprayed N occurred, while shoot growth significantly increased, compared with soil N applications. Besides a significant increase in leaf area was recorded, although net photosynthesis and chlorophyll concentration in the leaves did not vary. At harvest, lighter crop-loads were yielded by the trees subjected to the foliar sprays, and productivities were smaller than in soil N fertilized trees. Fruit quality traits measured at harvest showed increases in flesh firmness, soluble solids and juice acidity in the foliar sprayed trees. These results are discussed in terms of the contents of N and other mineral nutrients in leaves and shoots.

Keywords: apple, fruit growth, fruit quality, Malus domestica, mineral nutrition, nitrogen fertilization, yield
The situation of fruits and the effect of application K fertilizer on fruits of tropic and subtropic areas

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The fruits production developed quickly in Guangxi. The area planted to fruits such as mango, banana, etc. increased greatly, while that planted to food crops decreased. Adjustment of crop mix was key to increasing farmers' income. According to statistical results of 46 trials in Guangxi, application K fertilizer significantly increased yield over the application of NP fertilizer only. Application K fertilizer also increased quality of fruit markedly. When application K fertilizer was used for fruits income increased between 1,671-4,634 Yuan/ha. Application potassium fertilizer decreased the loss of nitrogen and phosphorus to the environment. Meanwhile application K fertilizer is useful for building soil fertility in Guangxi to achieve sustainable agricultural development.

Guangxi is located the humid sub-tropic and north part of tropic, which is the north latitude of 20°54´--26°30´ and the longitude of 104°29´--112°04´. It is about long of 750 km from east to west and the width of 610 km from south to north. The total area is 2.37x10^5 km^2. The landforms are complex. The parent materials grown soil is many and varied. The agricultural culture history is a long time. So, there are many soil types grown varied. The zonal soil are distributed the red soil, lateritic red loam and latosol from north to south of Guangxi. The type of the soil is also called the acid red soil. A total area is 10743.2 thousand ha and account for 66.55% in the soil of Guangxi. The acid red soil is a basis region of grain crops, cash crops, tropic and subtropical fruit trees, and special crops.

The original mineral of acid red soil was suffered from strong differentiation, and element K was leached out from the soil intensely. The ratio of translocation of K was 40.8-91.2%. Their total K content in soil was 0.511-0.857%. Slow available K content in soil was 12.3-1627mg/kg, average was 133.0 mg/kg. Available K content in soil was 12.8-302 mg/kg, average was 52.6 mg/kg.

Development of fruit trees production moved rapidly due to their profitability for farmers. The area planted to fruits such as mango, banana, etc. increased greatly, while that planted to food crops decreased. With crop diversification farmers’ income increased. In Guangxi, farmer average income was 1,204.56 Yuan/person/yr. from agricultural production in 1999; an increase of 721.52 Yuan/person/yr. or 149 percent from the farm income of 483.04 Yuan/person/yr. in 1989. One US dollar is roughly equivalent to 7.5 Yuan (RMB). According to statistical results of 46 trials in Guangxi, application K fertilizer significantly increased yield over the application of NP fertilizer only. For example, when fruit trees received application K fertilizer yield increases of 40.5, 38.9 percent and a range between 16.9-63.1 percent, respectively, were recorded. Application K fertilizer also increased quality of fruits markedly. For fruit trees, applying application K fertilizer, increased gross incomes between 4,424-25,043 Yuan/ha while net incomes ranged between 3,550-21,268 Yuan/ha. The fruit trees output/input ratio for application of potassium was 5.06 : 1 and 13.06 : 1. Application K fertilizer is useful for building soil fertility in Guangxi to achieve sustainable agricultural development. Even orchard fertility is enhanced. For example, the alkali-hydrolyzable nitrogen, available phosphate, available potassium and soil organic matter increased 26.1 mg/kg, 5.4 mg/kg, 32.8 mg/kg and 0.56 percent, respectively. And, soil bulk density decreased 0.34 g/cm^3.

Keywords: application K fertilizer, effect, fruits of tropic and sub-tropic
EFFECT OF KCl AND CaCl$_2$ SOIL APPLICATIONS ON TABLE GRAPES

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High soil saline concentrations affect plant water relationships, and they have developed physiological mechanisms to control this, like stomatal closure and osmoregulation. The latter allows the maintenance of water flux, because of an increased osmotic pressure. In a commercial table grape vineyard, cv. Thompson Seedless, in central Chile (34°20’ S, 71°17’ W) we carried out an experiment where concentrated solutions of CaCl$_2$ and KCl were applied to the soil regularly during December and January of the 2005/06 and 2006/07 growing seasons. Soil analyses verified that in the place where the concentrated solutions were applied Cl levels and E.C. where higher, but K and Ca levels were similar to the control. Foliar and fruit analyses showed that Cl concentrations were higher in leaves and fruits from trees where the solutes were applied, on both seasons. Shoot, bunch and berry weight did not differ between treatments. Berry firmness at harvest and 30 days after was higher in the treatment with solutes and berry dry mass percentage was lower. Cell area was measured in histological cuts of berries from both treatments, and larger cells were found in fruit from solute addition treatment. These results suggest that grapes have osmorregulation mechanisms that respond to high amounts of Cl in soil.

Keywords: osmorregulation mechanisms, saline soil, *Vitis vinifera*, water status.
THE EFFECT OF ALGAEGREEN 200 (COLD PROCESS SEAWEED LIQUID EXTRACT) ON THE MINERAL CONTENT OF BRAMLEY’S SEEDLING APPLE – LEAVES AND FRUIT

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AlgaeGreen 200 is a plant growth stimulant that is reported to increase yield over a wide range of annual temperate crops. Armagh apple growers have been using the seaweed extract as a foliar feed for two years and found that the trees were visually healthier looking in comparison to the untreated. However, there were no recorded measurements to support any claims on behalf of the treatment. Consequently it was decided to include AlgaeGreen 200 in the standard agrochemical evaluation trial for 2007. On this basis, the seaweed extract was applied to plots of mature Bramley trees on M26 rootstocks (two central assessed trees surrounded by guard rows) and compared with the unsprayed control. Both treatments were given full disease protection programmes and standard fertiliser. At harvest yield and disease parameters were recorded for each of the four replicates. The AlgaGreen 200 had no effect on disease levels and whilst the overall yield increased by 10%, there were no significant differences between the two treatments. Leaf and fruit analysis was undertaken in July, August and September and significant differences were detected between the seaweed treated plots and the controls. Tissue mineral analysis was performed using an Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES) and Kjeldahl analysis for total nitrogen. In the case of the leaf tissue, use of the seaweed significantly increased only the levels of lead in the leaves by September. In the case of the fruit, Zinc and Copper levels significantly increased with the use of the seaweed extract.
MANAGEMENT OF NITROGEN AND POTASSIUM FERTILIZER INPUTS ON ADULT FERTIGATED PEAR ORCHARDS AND ITS INFLUENCE ON YIELD

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Along six years (2000 – 2005) one field experiment was carried out in the Portuguese Region of Oeste in order to optimize the management of nitrogen and potassium fertilizer inputs with fertigation in soils under pear tree orchard cultivation. The experiment was installed at a fertigated pear orchard of the Portuguese cultivar Rocha, planted with a layout 4,5 x 2,0 m in 1991 and grafted on EMA. The experiment was designed into complete randomized blocks with three replications. Seven experimental treatments were considered, consisting of different partitions of the same levels of nitrogen and potassium fertilization (on average 40 kg ha⁻¹ N and 72 kg ha⁻¹ K₂O) along the annual vegetative cycle of the trees, plus a control, without fertilization. The obtained results show that the partition of nitrogen according to three times of application – 1/3 at bud stage + 1/3 after fruit set + 1/3 before fruits reached 14 mm of equatorial diameter plus the application of potassium every week, from bud stage to one week before harvest, lead to the highest mean yield (around 30 kg per tree). However, this treatment was not significant different (p=0.05) from the experimental treatments consisting of the application of nitrogen every week and the application of potassium three times a year. The quality parameters of the produced fruits (size, firmness of the pulp, total soluble solids, and titratable acidity) were within the adequate range values for the cultivar.

Keywords: pulp firmness, Pyrus communis “Rocha”, titratable acidity, total soluble solids, yield
A LONG-TERM EXPERIMENT ON OLIVE TREE WITH NITROGEN, PHOSPHORUS AND LIMESTONE FERTILIZATION

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In Portugal, an appreciable percentage of olive groves are installed in acid soils, with low levels of organic matter and nutrients, namely phosphorus. In a mature olive grove, cv. Verdeal Transmontana, located in Mirandela, in the Portuguese region of Trás-os-Montes, a field experiment was established in order to evaluate the effect of nitrogen, phosphorus and limestone applications on the yield and some quality parameters of olive oil. The experiment, installed on a Cambisol, was arranged into complete randomized blocks with three replications and eight experimental treatments resulting from 2³ combinations of two levels of each factor. The limestone was applied only in the first experimental year (10 000 kg ha⁻¹) and phosphorus was applied annually from 1987 to 1994 (0 and 34 kg ha⁻¹ P). Regarding nitrogen, the annual levels used were 94 and 188 kg ha⁻¹ N from 1987 to 1994, changing to 0 and 78 kg ha⁻¹ N from 1995 to 2006. In this last period, only the residual effect of limestone and phosphorus was studied. Experimental results obtained from 1995 to 2006 show an increase on fruit-yield due nitrogen and limestone applications, respectively 35% and 18%. In what concerns fruit-mean weight and fruit-fat content, as well as the quality parameters of olive oil (acidity, peroxide value, specific absorbance coefficients K₂₃₂ and K₂₇₀, total polyphenols, waxes and total sterols), they were not significantly affected (p>0.05) by fertilization. On opposite, the oxidative stability increased with phosphorus application. In acid soils poor in organic matter is advantageous liming and nitrogen application, resulting in higher fruit-yield, without affecting olive oil quality.

Keywords: fertilization, Olea europaea L., olive oil quality, yield
INFLUENCE OF NITROGEN AND POTASSIUM FERTILIZATION ON MINERAL COMPOSITION OF KIWIFRUIT

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Physiological disorders during fruit storage are common, leading to remarkable losses of marketable yield, could be strongly affected by the mineral composition of fruits at harvest. The present study was conducted during three years and was based on experimental data obtained from a fertilizer trial arranged into completely randomized blocks, with three replications, installed in an orchard in the Portuguese Region of Bairrada. This experiment was established in order to evaluate the influence of nitrogen and potassium fertilization on the yield and fruit mineral composition of Actinidia deliciosa cv. Hayward. Three levels of nitrogen (30, 60, and 90 kg ha⁻¹ N) and four levels of potassium (0, 45, 90 and 135 kg ha⁻¹ K₂O) were used, arranged into 12 experimental treatments. Since 2004, nitrogen and potassium was applied annualy. Total yield and its distribution according to fruit size from each plot: [65 -75g], [75 -85g], [85 -105g] and >105g was evaluated. A sample of 16 fruits of each fruit size was taken from each plot and analysed (N, P, K, Ca, Mg, S, Na, Fe, Mn, Zn, Cu and B). The present paper reports the first set of experimental results, corresponding to the experimental period from 2004 to 2006.

Keywords: Actinidia deliciosa, fertilization, mineral composition, yield.
INFLUENCE OF BORON FOLIAR SPRAYS ON FRUIT GROWTH AND SEED NUMBER OF HAYWARD KIWFUSTR

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The effect of foliar boric acid (17% of B) sprays at 500 mg L⁻¹ concentration on fruit growth of Actinidia deliciosa has been studied in a commercial Hayward orchard, pollinated with Matua and Tomuri males. Applications were made in spring fruiting shoots, spraying over distal leaves or over recently opened flowers, comparing with no sprayed shoots (control). Summer foliar level of boron in female plants was about 30 ppm, regarded adequate. At harvest time, fruits were measured in weight and both diameters and for weight and number of seeds.

Fruit of shoots with boron sprayed leaves produced 43% more seeds than control fruits (892 over 622), instead shoots with sprayed flowers increased seed number in 44% (894 over 622). There were no significant differences in the individual seed weight among treatments (1.46 mg for flower sprayed, 1.47 mg for leaves sprayed and 1.44 mg for control).

Concerning fruit weight, shoots with sprayed leaves reached 14% more than control (83.6 g over 73.3 g) and sprayed flowers showed 17% more than non sprayed shoots (85.9 g over 73.3 g).

Results suggest that in Actinidia deliciosa cv. Hayward, Boron has an effect in improving seed number per fruit and consequently in getting bigger fruits concerning weight and diameter. In conclusion and for this trial conditions, spraying of boric acid solutions over leaves and flowers of kiwifruit shoots, was effective in increasing seed number and fruit weight, improving fruit quality and probably further market prices.

Keywords: Actinidia deliciosa, boron, fruit weight, seed number
EFFECTS OF FOLIAR APPLICATION OF Fe AND Zn ON GRAPEVINE VEGETATIVE AND REPRODUCTIVE

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Grape (Vitis vinifera L.) is one of the most important fruits that grown and consumed in a number of ways for thousands of years. Due to high soil pH, many cultivars of grapevine show symptoms of Fe and Zn deficiency. Attempts have been made to reduce symptoms of Fe and Zn deficiencies by foliar application of Fe and Zn. The experiment carried out in 2 successive years in the 2 locations: a) dry farming condition and b) irrigated condition. In this experiment Fe and Zn (FeSO₄·7H₂O, ZnSO₄·7H₂O) were sprayed to the plants at two different times: 2 weeks before and 2 weeks after bloom. The design of experiment was complete randomized block design with 3 replications. Treatments include: 1) 0, 400 and 800 mg/l Fe  2) 0, 300, and 600 mg/l Zn  3) Fe + Zn (at 2 rates 400+300 and 800+600 mg/l).

In the irrigated condition sprayed of Zn and Fe caused increase of shoot length, leaf surface and chlorophyll. In dry farming shoot length and chlorophyll increased but this increase was less than irrigated. Total fruits per vine, weight bunch and number of berry per bunch in irrigated condition increased in the 800mg/l Fe + 600mg/l Zn treatment. this increase in dry farming belonged to 400mg/l Fe + 300 mg/l Zn treatment.

The best results obtained with 800 mg/l + 600 mg/l Zn in irrigated but 400 mg/l Fe + 300mg/l Zn in dry farming vineyard was the best.

Keyword: foliar application, grapevine, Vitis vinifera
STUDY OF A RELATIONSHIP BETWEEN NITROGEN AND POTASSIUM ABSORPTION USED AS FERTILIZERS ON *PYRUM COMMUNIS* L., CULTIVARS ABATE AND CONFERENCE

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The aim of this research is to evaluate the correct fertilizing for *Pyrus communis* L., in particular for Abate and Conference cultivars. The field experiment was performed in an orchard located in Finale Emilia (Modena, Italy) for a period of two years. The used scheme was a split-plot, where a supply of 100, 200, 300 kg/hectare of nitrogen where crossed with different doses of K$_2$O: 0, 100 and 200 kg/hectare, plus a blank without any fertilizer.

The absorption of macro and micro-elements from leaves and fruits was followed during the tree development in June, July and August in order to evaluate the effect of the different fertilizers.

At the harvest time, the crop productivity was evaluated, by weighting the fruits of ten plants for each thesis, also measuring the physico-chemical characters of the fruits. These last parameters were also measured after five months of cold storage, to evaluate the fruit storability.

The two cultivars showed a different sensibility in the accumulation of mineral elements both in leaves and fruits. Potassium seems to induce an higher influence than Nitrogen on both positive and negative uptake of macro and micro elements.

The productivity are always negatively affected by the Nitrogen and Potassium supplies in both cultivars.

For what concern the quality of the fruits, the two cultivars didn’t give the same feedback to the treatments; the fruits’ physico-chemical characters seemed to be mainly influenced by the Nitrogen absorption, with a stronger effect on Abate. Particularly, the different manure thesis had no effect on the sugar content, while increasing potassium induced an increase of fruit’s acidity.

Even more, as concerning the fruits storability, the blank presents a large amount of rejects after storage, the one treated with the largest potassium supply has a significant less rejects.

**Keywords:** nitrogen, pear, potassium, storability
**BENEFITS OF THE MIXED AMMONIUM / NITRATE NUTRITION IN OLIVE TREES**

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Nitrate leaching is an important process of nitrogen losses in the Spanish agricultural system. As a consequence more than 12% of Spain surface has been declared as vulnerable area to groundwater nitrate pollution according to the 91/676/CEE legislation. In these situation Spanish growers has to improve their fertilization practices with the aim of decrease nitrogen losses but keeping the profitability of their orchards. Fertigation is one of the solutions to this problem, with this method is possible to make a more efficient irrigation control and a great fractioning of the nitrogen inputs. A complementary tool for improve N fertilisers efficiency is the control of N chemical cycle in the soil. Nitrification inhibitors are added to any type of fertilizers and delay the bacteria oxidation of $\text{NH}_4^+$ to $\text{NO}_3^-$ (Prasad and Power, 1995), due to the competition for the active site in the enzyme AMO (McCarty, 1999). Nitrification inhibitors increase ammonium-N and decrease nitrate-N in soils, as a result they also decrease N losses through nitrate lixiviation and washing out. Nitrogen use efficiency is improved, the N doses can be reduced and the fertigation can be more flexible with less risk of N looses. Finally these benefits produce an economical and environmental benefit (Trenkel, 1997). This paper present three trials performed in olive trees, comparing in different circumstances and systems, the consequences of the use of nitrogen conventional fertilisers and fertilisers with the nitrification inhibitor 3,4 dimethylpirazole phosphate (DMPP). All the trials were performed in Spain and under fertigation system. The trial one is performed by the Polytechnic University of Valencia from 2004 to 2006, in the area of Castellon with young olive trees (4 years old) variety Serrana de Espadan. Each tree is fertilised with approximately 175, 220 and 240 g nitrogen · tree⁻¹ for 2004, 2005 and 2006 respectively, with and without the nitrification inhibitor DMPP. The trial two is performed with an intensive olive trees orchard (1666 trees·ha⁻¹), in the area of La Rioja, the variety is arbequina. The fertigation with conventional fertilisers is compared with a planning that include nitrification inhibitors, with similar N-P-K applied (103 kg N·ha⁻¹). The results of this trial are only from the first year. The trial 3 is performed in greenhouse conditions in the Cordoba University. In a trial with a randomized blocks design (4 replications per treatment) the small olive trees variety picual were planted in pots of 2 litters (50% natural soil, 25% sand and 25% organic substrate). In this case was compared a N fertirigation with ammonium sulphate with a identical planning with ammonium sulphate + DMPP.

In terms of yield and quality the results in the trials in field conditions (trials 1 and 2, in Castellón and La Rioja) were very similar. The use of ammonium fertilisers + nitrification inhibitor increase the growth of the lateral branches and the number of buds (an average of 29-33%). This result probably
is related with the energy saving associated with ammonium nutrition and with the effects over the phytohormones equilibrium. The final yield is improved with this kind of mixed fertilization by an increase of the total yield per ha and by a higher oil content if the olive fruits (and average of 5-8%). The principal objective of the trial performed in Córdoba (trial 3) under greenhouse conditions was the study of the N losses by leaching with the different fertilisers compared. The results show that with a conventional fertilization the global N-losses were a 48% of the N applied, and with the inclusion of the nitrification inhibitor this losses were reduced to 32%. The global extractions by the trees were similar between treatments, but the use of the nitrification inhibitor produce a significant increase of N retention in the soil, that finally improves the efficiency of the nitrogen fertilization. The global conclusions of the trials presented are that the olive crop has a positive response to the increase of the N-ammonium nutrition, in terms of growth and yields and in the reduction of N-pollution.

**Keywords:** DMPP, 3,4-dimethylpyrazol phosphate, nitrate leaching, nitrification inhibitor, olive tree

EFFECT OF FOLIAR BORON APPLICATION ON GROWTH, PHENOLOGY, YIELD AND OIL QUALITY OF OLIVE TREES (CV. ARBEQUINA) CONDUCTED UNDER A HIGH DENSITY PLANTING SYSTEM

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A 2-year field study was carried out to determine if foliar B sprays could affect vegetative growth, percentage of perfect flowers, fruit set, yield, fruit characteristics, oil content and oil quality of olive cv. Arbequina 118 grown in a high density planting system. Boron foliar treatments (300 mg l⁻¹ as Solubore DF) were applied at 2 different dates each year, prior to flowering and just after fruit set, to trees with no vegetative symptoms of B deficiency. Leaf B was measured two times during 2006, at fruit set and mid-July. Results obtained indicated that leaf B level increased after the first application as compared to controls. After the July treatment, leaf B levels in controls and the treated trees increased when compared to the first sampling date, which indicated that a high consumption of B occurred during the flowering period. Foliar B application had no significant effect on vegetative growth during both years. During the first year of study, B sprays had no significant effect on several phenological characteristics, including fruit set, yield, fruit size and oil contents. The first year of study was considered an “on year” because of the higher production. On the second year, B sprays improved blooming rate, which increased from 20% in controls to 30% in treated trees, and olive yield, which increased by 27% in response to B. However, this increase of blooming rate was not accompanied by an increase in percentage of perfect flowers and fruit set. In the second year of study, yield of control trees decreased by 46% as compared to the first year, which indicates that the second year was an “off year”. The increase of yield in response to foliar B sprays was not accompanied by a reduction in fruit size. In respect to oil quality, no effect of B foliar sprays was observed in oil characteristics such as polyphenol contents, fatty acid composition, K232 and K270 content and oxidative stability. In conclusion, the response of olive to foliar B application was significant only in the “off year”, characterized by lower production.
SULPHUR APPLICATION EFFECT IN GRAPEVINES LEAVES. PRELIMINARY RESULTS

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The sulphur (S) is used by the growers of the whole world against powdery mildew of grapes. In the Bairrada Region, with the variety Bical grapevine, a field trial was conducted throughout a cultural cycle to evaluate the effect of the application of different formulations and concentrations of sulphur, namely in the absorption of S by grapevines leaves. Two formulations were used in different concentrations (Dust: 30-50kg/ha (E); wettable sulphur: 4kg/ha (MB); 8kg/ha (MM) and 12,5kg/ha (MA)). The samples were collected at vine harvest, on leaves (limbs and petioles) of the 7th basal knot of 40 grapevines for modality treatment (1 leaf for plant). In laboratory it was carried out the research of S in 20 washed leaves and 20 non washed leaves, for modality. Data had been analyzed comparing averages in the different modalities and the control. Results showed higher values of S in modalities E and MA, in complete leaves. In limbs, the modality E was the one that presented high values of S. In petioles the modality MA appears with high values of S. There was a trend for the E and MA to present higher values of S.

Keywords: absorption, concentration, formulations, leaves, sulphur, \textit{Vitis vinifera}
MANAGEMENT OF IRON DEFICIENCY CHLOROSIS IN CITRUS THROUGH INTERCROPPING WITH PERENNIAL GRASS SPECIES

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The objective of this experiment was to investigate the influence of intercropping citrumelo “Swingle” (Citrus paradisi Macf. x Poncirus trifoliata); a highly susceptible rootstock to Fe deficiency with perennial graminaceous species (Festuca ovina L., Festuca rubra subsp. tricophylla L., and Poa nemoralis L.) on its Fe nutritional status. One-year old citrumelo plants were grown on calcareous soil-sand mixture under greenhouse conditions and treated as follows: (1) citrumelo plants grown in a monoculture system (without a companion crop); (2) citrumelo plants fertilized with 18.6 mg Fe per plant in form of FeEDDHA; (3) citrumelo plants separately intercropped with the three perennial grass species. These grasses were sown at a rate of 3 seeds cm⁻², mowed only one time and allowed to re-grow. Chlorophyll measurements were performed on the youngest fully expanded leaves in terms of SPAD index and at the end of the experiment leaf chlorophyll concentration (µg cm⁻²), leaf Fe concentration (µg g⁻¹ DW), leaf length and width and dry weight of young shoots (g) were determined. Intercropping citrumelo plants with F. rubra was as effective as FeEDDHA in efficiently preventing the development of leaf chlorosis and improving their growth vigor compared to the control plants while those intercropped with F. ovina overcame Fe deficiency symptoms only after mowing/clipping this grass species. The Poa nemoralis did not demonstrate any potential to prevent leaf chlorosis or improve the growth vigor of citrumelo plants. These results confirm that intercropping fruit trees with some grass species is an effective ecological orchard floor management practice to correct/prevent Fe deficiency chlorosis.

Keywords: citrumelo “Swingle”, intercropping, iron chlorosis, phytosiderophores
EFFECT OF FOLIAR NUTRITION ON FRUIT PROPERTIES AND ALTERNATE BEARING BEHAVIOUR OF PISTACHIO (*Pistacia vera* L.) TREES

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Pistachio (*Pistacia vera* L.) is a strategic product of Islamic Republic of Iran and has a unique position in export goods. In respect to the important role of fruit quality such as seedlessness, shell splitting in exporting of the product, the research was conducted during 2006-2007. In this research we applied several nutrients as foliar application to surmount soil limitations in nutrient uptake and alternate bearing control with “Fandoghee” cultivar in RCBD with 3 replications. The treatments were control (water application), NPK, Fe, Ca, Mg, Mn, Zn, Cu and mixture of all mention nutrients (Zn+Cu+Mn+Mg+Ca+Fe+NPK) in three stage (15 day AFB, kernel filling and one month before harvest). Factors such as shell splitting, seedlessness, fruit weight/stem cross section area (g/mm$^2$), vegetative growth, leaf chlorophyll and nutrient content were determined. The results showed that treatments affect shell splitting properties significantly as the highest level of shell splitting (60%) was detected in Ca treatment and the lowest one (32%) in control. There is not significant differences between treatments as seedlessness and chlorophyll content as concerned. Fruit weight/stem cross section area in two successive years had significant differences and in two years the highest yield was produced in NPK (1.42 g/mm$^2$) and Cu (1 g/mm$^2$) treatment respectively but the lowest yield produced in mixture nutrients treatment. The highest cumulative fruit weight/shoot cross section area in two successive years detected in NPK, Cu and Zn treatments but the lowest fluctuation in fruit weight in two successive year detected in Zn and Fe treatment therfore the lowest alternate bearing was detected in Zn and Fe treatments. All treatment affected vegetative growth significantly as the highest growth (4.83 cm) take placed in Cu treatment and the lowest growth (2cm) was detected in mixture nutrients treatment. Leaf nutrients analysis showed significant differedenced between control, NPK and mixture treatments as Nitrogen, Phosphorus and K content were significantly higher in NPK and mixture treatments than control. Manganese content of the leaf was higher in Mn and mixture treatments than control. In conclusion, foliar nutrition can affect growth, fruit quality and alternate bearing control of the trees and in “Fandoghee” cultivar Cu and Zn folia nutrition is prior to other nutrients.

Keywords: alternate bearing, foliar nutrition, nutrient, pistachio
EFFICIENCY OF BORON FOLIAR FERTILIZATION IN LYCHEE (*Litchi chinensis* Sonn.)

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Lychee is grown in mountainous regions in Southeast Asia. During the winter season with low temperature and high radiation, severe chlorosis are observed on south-southwest exposed branches, inhibiting flowering. This is probably due to a missing compensation of photooxidative stress caused by the widespread extremely low Boron and/or Zinc nutritional status of Lychee trees.

Soil applied Boron is easily bound (high soil pH) or leached after heavy rainfall (low soil pH). Since B is phloem immobile in most plant species, foliar B fertilization is a widespread technique to cure B deficiencies. The performance of foliar sprays is still variable, depending on nutrient amount, weather conditions, timing and status quo of the plant. The aim of this work was to survey the role of the lower (abaxial) leaf surface and to study the influence of plant nutritional status on foliar penetration, uptake and translocation, hypothesizing an increased uptake thus better distribution after application on the lower leaf surface in deficient plants.

Experiments were conducted under controlled conditions. Stable isotope enriched boric acid was applied to Lychee leaves with low and adequate B nutritional status, achieved by a different preculture in nutrient solution. Treatments were supplied either on the upper (adaxial) or lower leaf surface. At harvest, plants were separated in different segments to determine uptake, acropetal and basipetal translocation of foliar applied B.

We quantified penetration and translocation of the applied stable isotope $^{10}$B in each treatment. Acropetal translocation of $^{10}$B from application zone to leaf tip was highest, decreasing to a lower content in leaflets where B was basipetal translocated. There was no translocation into meristemic (sink) tissue. The amount of $^{10}$B in all segments was increased under low B nutritional status of the trees. Penetration and translocation of B applied on the upper or lower leaf surface showed no significant differences.

In conclusion, application to the lower leaf surface has no practical relevance in Lychee so far, the increase in penetration and translocation of foliar applied B of B-deficient leaves approved our hypothesis.

**Keywords:** boron, lychee, photooxidative stress, zinc
NUTRIVANT – A BREAKTHROUGH IN FOLIAR NUTRITION

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Foliar application of fertilizers is practiced when a quick and direct action is to answer specific needs, or when complimentary nutrition is required to amend plant temporal and / or spatial shortages. However, the efficiency of agrochemicals applied as foliar spray is greatly reduced by the fact that the plant leaves has a natural ‘skin’ called the cuticle, a tough lipid membrane that blocks the penetration of nutritional elements as well as pesticides, bio-stimulants and hormones. Developed by scientists at Israel’s Ben Gurion University, FertiVant is an adjuvant specifically designed for foliar application, which breaks through this barrier. FertiVant has advanced and prolonged delivery system and works in the following manner: using a unique “coral pattern” it evenly spreads the drops of spray on the leaf surface while firmly attaching the active ingredients to the leaf surface and delaying evaporation. As important, it speeds up the cuticle permeability to the active substances. FertiVant, unlike silicon based products, is non-harmful to the plant tissue, non-toxic to plant or the environment and is biodegradable.

The NutriVant product line is FertiVant based and has been tested for five years of intensive laboratory research and field experiments. NutriVant has demonstrated to be superior to other such products on the market today. For growers, NutriVant offers a number of outstanding, proven benefits: an unprecedented increase in size and quantity of fruit, improved crop quality, higher and faster penetration of nutritional elements of ionic (MKP and KNO₃), non-ionic (urea) fertilizers, and microelements, and calls for reduced spray volume, which can lower spray cost per hectare. NutriVant products offer advanced nutritional formula mixes containing by need macro-and-microelements. Products are tailored to supply nutrients at high amount and purity, to suit specific phenological events such as early development stage or fruit development and to answer demands of specific crops such as citrus, olive, avocado, mango and other orchard crops as well as vegetables, cereal crops and more.
SESSION 06
MINERAL NUTRITION AND HUMAN HEALTH
FRUIT CROP NUTRITIONAL QUALITY: IMPLICATIONS FOR HUMAN HEALTH

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Humans require several minerals and vitamins for successful growth, development, and general health and well-being. These essential nutrients must be obtained from dietary sources in bioavailable forms, with the recommended daily intakes varying according to the life-stage of the individual (e.g., infant, adolescent, adult, pregnancy, lactation, etc.). Plant foods are an important source of dietary nutrients, especially with respect to minerals. Interestingly, the concentration of minerals in plant food products is as varied as the plant species that comprise our food supply, or the cultivars grown for any given crop. Tree fruit are no exception, with mineral composition varying dramatically across species, especially when considering the fruit as consumed (i.e., fresh weight basis of a common serving size). Nonetheless, all fruit crops can contribute to the daily requirements of certain minerals. They also can provide food components that enhance the absorption of minerals from other dietary sources. In this presentation, I will give an overview of human mineral requirements and will summarize the potential contribution of various tree fruit crops to these daily needs. I will present information on existing genetic variation for mineral concentrations in fruit crops, and will discuss some of the whole-plant processes that facilitate the delivery of minerals to fruit. Finally, I will demonstrate how cultivation and fertilization practices contribute to the ultimate nutritional quality of harvested fruit products, and will offer strategies that could help to enhance the mineral composition of fruit in our food supply.

Keywords: bioavailability, dietary requirements, genetic diversity, mineral composition
MANIPULATION OF NITROGEN APPLICATION IN THE VINEYARD TO OPTIMISE THE SECONDARY METABOLITE PROFILE OF WINES TO MEET CONSUMER DEMAND

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The aim of this study was to understand how vine and must nutrient status influences the concentration and composition of secondary metabolites in red grapes and wine and how this impacts on the sensory attributes of the final wine. In 2006 different rates of nitrogen fertiliser were applied to Shiraz vines grown in Langhorne Creek, South Australia. In the first season (2006/2007) it was confirmed that this site was low in nitrogen and thus responded to the application of nitrogen. The application of nitrogen increased the concentration of ammonia, total amino acids and each individual amino acid and YAN (yeast assimilable nitrogen) in the berry at each sample date. In contrast the YNAN (yeast non-assimilable nitrogen) decreased in response to nitrogen application. While both proline and arginine increased in response to nitrogen the proline to arginine ratio decreased as has been previously reported in the literature. Interestingly, the application of nitrogen increased the concentration of PR proteins in the berry at harvest and this included both the thaumatin-like and chitinase proteins. While this is not of great significance for Shiraz wines, being a red variety and one that accumulates relatively low levels of PR proteins, it has significance for other varieties such as Sauvignon Blanc which accumulate high concentrations of PR proteins. The vines receiving nitrogen had lower concentrations of total anthocyanins (HPLC) and total tannins in berries sampled at harvest. Therefore, it appears that there is potential to manipulate some of the secondary metabolites in grapes via nitrogen application in the vineyard.
EFFECT OF MINERAL AND ORGANIC FERTILIZATION AND RIPENING STAGE ON VOLATILE ORGANIC COMPOUNDS EMISSION AND ANTIOXIDANT ACTIVITY OF NECTARINE STARK REDGOLD

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The objectives of this experiment were to evaluate the effect of fertilization (mineral vs organic) and ripening stage (pre climateric vs climateric) on: 1. emission of volatile organic compounds (VOCs), 2. antioxidant activity of nectarine fruits. The investigation was conducted in 2007 in an experimental peach orchard of nectarine (Prunus persica leavis) Stark Red Gold on GF677 peach x almond hybrid that, since its plantation (2001), was subjected to the following experimental treatments: 1. mineral fertilization including N (100 kg ha⁻¹ year⁻¹) split at 40 days after full bloom (60%) and in September (40%); 2. compost (10 t DW ha⁻¹ year⁻¹) split as above. Nectarine were harvested every day from July 22 to August 3 (one block per day) and ripening stage was evaluated on 10-15 kg of fruits by Near Infra Red (NIR) spectrophotometry technique. After harvest, fruit samples were taken to the lab and divided in 2 groups according to the difference of absorbance between 670 and 720 μm:< 0.4 (corresponding to a flesh firmness < 1.5 kg); and > 0.9 (flesh firmness > 5 kg). The same day of harvest, peaches were measured for VOCs emission by gaschromatographic analysis of an overhead air samples after incubating a whole peach into a sealed jar for 40 minutes. VOCs determination was carried out on 2 peaches per treatment (8 per day), for a total of 40 peaches. Preliminary results show that not oxygenate terpene (i. e. α−farnesene) detected in pre-climateric ripening stage, disappeared with the ripening process. Nectarine fertilized with compost showed a higher emission of linalool, γ−decalactones and esters (i. e. exyl acetate, methyl octanoate, ethyl octanoate) than in fruits from plots supplied with mineral fertilizer. The antioxidant activity was higher in peel than in flesh.

Keywords: compost, fruit firmness, linalool, NIR
VITAMIN C CONTENT OF CITRUS FROM CONVENTIONAL AND ORGANIC FARMING

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The fertilization in the citrus culture is a cultural practice with great importance. It affects significantly the quality of the fruits. This work had the purpose to evaluate the effects of different levels of fertilization in the internal and external characteristics of citrus. The study was carried out in different orchards of the Algarve region, at the south of Portugal. It included: 1) orchards, where there is no application of fertilizers in the last five years; 2) orchards in organic farming and 3) orchards where mineral fertilizer application is done all throughout the vegetative cycle of the plants.

Fruits of the different orchards had been harvested and submitted to physical and chemical analyses as well as to a sensorial test. The analyses showed that the mineral fertilization provided a greater weight and diameter of the fruits, thicker peel and greater colour and maturation indices, in the majority of the cultivars. The fruits of unfertilized orchards had greater soluble solid content, bigger total acidity and a bigger dry weight of the peel. Only to the fruit shape did not find a direct relationship with the fertilization. The sensorial analyse test revealed that the fruits of the fertilized orchard presents better external appearance but lesser flavour when compared with the fruits of the no fertilized orchard.

It was determined that the medium weight and the dimensions of the fruit were higher in the fruits coming from conventional orchards. In this form of agriculture it was recorded the largest juice percentage, the smallest concentration of acidity, the most intense coloration, the largest tenor of soluble solids and the higher maturation index. By opposite, the smallest thickness of the fruits peel and the highest concentrations of vitamin C and sugars (fructose, glucose and sucrose) were recorded in the fruits from organic farming.
EFFECT OF BORON AND CALCIUM SPRAYING ON PHOTOSYNTHETIC PIGMENTS, TOTAL PHENOL, ANTHOCYANIN AND FLAVONOID CONTENT OF SWEET CHERRY (*PRUNUS AVIUM*, L.)

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Aim of our study was to establish the effect of a three-years-long boron and calcium treatment on some phytochemical compounds of sweet cherry (*Prunus avium*, L.) leaves and fruits. In our trial we used eight-year-old cv. ‘Germersdorfi 3’ grafted on Prunus mahaleb rootstock. Boron treatment was done by spraying boric acid, while calcium treatment was fulfilled with calcium nitrate spraying, respectively. Photosynthetic pigment and total phenol content of sweet cherry leaves and total anthocyanin, total flavonoid and total phenol content of sweet cherry fruits were measured, respectively. Boron spraying at blooming time has a positive effect on photosynthetic pigments content of sweet cherry leaves, contrary to double times spraying reduces their content. Total carotenoids respond similarly to boron spraying: single treatment increases their mass, two-times spraying has a negative effect on the total carotenoid content of the leaves, respectively. Every calcium treatment increased the chlorophyll\textsubscript{a} and chlorophyll\textsubscript{b} content. The mass of carotenoids were also in close connection with the calcium spraying. It is to be noted that time and frequency of application influenced the mass of both photosynthetic pigments. Effect of boron and calcium spraying on total phenol content was significant. After double boron treatment, quantity of total phenol content was just ninth of the control leaves. Boron and calcium spraying decreased the total phenol, anthocyanin and flavonoids content in sweet cherry fruits, respectively. However, boron treatment was more effective than calcium sprayings. Conclusion of boron and calcium spraying was significant in most cases of our trial.

**Keywords:** boron, calcium, phytochemical compounds, sweet cherry
SESSION 07

EFFECT OF MINERAL NUTRITION ON FRUIT QUALITY AND NUTRITIONAL DISORDERS
EFFECTS OF MINERAL NUTRITION ON FRUIT QUALITY AND NUTRITIONAL DISORDERS IN APPLES

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Leaf mineral analysis is a useful tool to diagnosis apple tree deficiencies but often is poorly related to fruit quality. Using fruit analysis alone or in combination with leaf analysis often permits more precise prediction of fruit quality. Over the last several years, we have developed several models for predicting apple fruit quality. In addition, we have examined the effects of various orchard factors and cultural practices, such as irrigation, rootstocks, and foliar application of nutritional sprays, on apple fruit mineral composition and quality. A ranking of major minerals has been developed that predicts fruit quality within a year and between years. Increasing fruit N is inversely related to fruit yellow or red color and positively associated with fruit respiration and ethylene. Fruit Ca tends to be imprecisely related to bitter pit and fruit firmness. Multiple sprays of soluble Ca often reduce bitter pit and usually but not always increase Ca concentrations in subdermal cortical tissue. Early-season Ca sprays often are more effective than later sprays at reducing bitter pit; however, later applications of Ca have a greater influence on fruit Ca. The B concentration of apple fruit is much more strongly affected by early season B sprays that is B in leaves. Fruit from B-sprayed trees may exhibit quality loss due to B excess even though leaf B appears normal. Water stress reduced leaf and fruit K but increased leaf Mg. An overview of several orchard factors on mineral nutrition and fruit quality and disorders will be presented.

Keywords: Malus x domestica, postharvest, preharvest, storage
ADDIION OF NITROGEN HAD NO EFFECT ON YIELD AND QUALITY OF APPLES IN AN HIGH DENSITY ORCHARD CARRYING A DWARF ROOTSTOCK

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The effect of N addition on apple yield and quality may vary according to the tree vigor. Apple trees developed over vigorous rootstocks had shown no response to N application in Brazil. In this study it was evaluated the effect of N addition to the soil on yield and quality of ´Royal Gala´ apples grafted on a dwarf (M.9) rootstock. The orchard was planted in 1996 (2,857 trees ha\(^{-1}\)) on an Oxisol containing 4.0% organic matter and pH 6.0. The experiment was carried out from 1998 up to 2005. Treatments consisted of rates of N (0, 50, 100 and 150 kg ha\(^{-1}\) year\(^{-1}\) from 1998 to 2001, which were increased respectively to 0, 100, 200 and 300 kg ha\(^{-1}\) afterwards), all broadcast within the tree row in two equal splits, at bud break and after harvest, as ammonium sulfate. Addition of N to the soil had no effect on fruit yield over the six years regardless of rate applied. Averaged across treatments and years, fruit yield was 52.3 t ha\(^{-1}\). Nitrogen in the leaves (average of 2.40%) or in the fruits (average of 346 mg kg\(^{-1}\)) as well as some parameters related to fruit quality (color, firmness, acidity, soluble solids, physiological disorders) were unaffected by N addition. Thus, it is not necessary to apply N to assure good fruit quality and yield to high-density orchards carrying dwarf rootstocks in Brazil probably because the N required for tree growth and fruit production is supplied from soil organic matter decay.

Keywords: apple yield, dwarf rootstock, fruit quality, nitrogen
POLYPHENOLOXIDASE ISOZYMES IN BITTER PIT AFFECTED APPLE TISSUES EITHER NATURALLY OR LOCALLY INDUCED BY AMMONIUM OXALATE INJECTIONS

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Ca-related disorders in fruits lead to cell collapse, resulting in tissue enzymatic browning, caused by polyphenol oxidase (PPO) and peroxidase enzymes. PPOs are responsible for the enzymatic browning reaction that occurs in damaged fruits or vegetables. Corky spots have greater concentrations of calcium, magnesium and potassium and greater PPO activity. In this work, electrophoresis was used for detection and comparison of active PPO isoforms from ‘Golden Delicious’ apple fruit tissues. Three types of materials were studied: sound apple pulp, bitter pit affected pulp and corky lesions induced by ammonium oxalate subdermal injections. Non-denaturing native gels were stained for PPO activity with 27 mM catechol in 0.1 M sodium acetate buffer, pH 7.0. Three main isozymes were detected in the pulp of sound apple. In bitter pit affected tissue, the intensity of the two bands of high molecular weight decreased and two new isoforms appeared, one below the one of greater mass, and another in the zone of low molecular weight. However, in oxalate induced corky tissue, the lowest molecular weight PPO isoform found, did not appear while the rest of the pattern was analogous. This indicates that, although the natural process of bitter pit development and the chemically induced one finally result in dehydrated brown tissue that accumulates calcium and shows greater PPO activity, the two processes must follow different metabolic routes, or that the speediness of the spots appearance in the induced process, does not allow the adjustment of the isoynzymatic system as it occurs in the natural process.

Keywords: browning, isozyymes, Malus domestica, PPO
RE-ASSESSMENT OF PRE-HARVEST PHYSIOLOGICAL INFILTRATION METHODS FOR COMMERCIAL BITTER PIT PREDICTION IN ‘BRAEBURN’ AND ‘GOLDEN DELICIOUS’

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Although management practices are followed to reduce the incidence of bitter pit in commercial orchards, this defect still surfaces regularly and causes serious problems with fruit quality that leads to losses in especially export produce. Current methods e.g. fruit mineral analysis, magnesium (Mg) infiltration and ethylene forcing that were developed to predict bitter pit incidence, vary in reliability. However, there is still a need to predict bitter pit incidence commercially, before it becomes visible. The effectiveness of ethylene forcing and Mg infiltration - were re-assessed under local conditions for ‘Braeburn’ and ‘Golden Delicious’ apples. The correlation coefficients for the two methods were compared, as well as the correlations between the bitter pit-like incidence of the individual methods and actual bitter pit after storage. During the first season, the correlation coefficient for Mg infiltration and actual bitter pit (r = 0.45) was higher compared to the coefficient for ethylene forcing and actual bitter pit (r = 0.13). The R² for the linear relationship between bitter pit incidence with Mg-infiltration and ethylene forcing was 0.43. The actual bitter pit incidence per season influenced the accuracy of the methods. The laboratory results were then extrapolated to accommodate commercial predictions and compared with the commercial service rendered at present.

Keywords: apple, Ca concentration, ethylene forcing, magnesium infiltration
INFLUENCE OF FOLIAR FERTILIZATION ON SUGAR AND ORGANIC ACID CONTENT IN CHERRY FRUIT (PRUNUS AVIUM, L.)

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Influence of foliar fertilization on content of sugars (glucose, fructose, galactose and saccharose) of sweet cherries (Prunus avium L.) and organic acids (citric, malic and fumaric acid) was studied. The experiment was conducted during 2005–2007 in West Hungary on mature cv. ‘Germersdorfi 3’ grafted on Prunus mahaleb rootstock, planted in 1999. Trees spaced 7 x 5 m, and growing in a calcareous chernozem soil.

Trees were foliar-fertilized with potassium as KNO₃, calcium as Ca(NO₃)₂ and boron as boric acid. Boron spraying was conducted at blooming time and 5 weeks later. Potassium and Calcium spraying was carried out 3 and 5 weeks after full bloom. Beside fruit analysis, complete soil and leaf analysis were done to study the rate of nutrient uptake and its effects on fruit quality.

Contents of nutrients of soil and leaf were determined by atomic absorption and spectrophotometric method, while sugars and organic acids in fruit were determined by HPLC. From applied treatments only the boron treatments had significant increasing effect on contents of all examined sugars, compared the control.

Furthermore, the effect of calcium spraying on the contents of organic acids was significant only while boron applications caused lower acid contents in fruit.

Keywords: cherry, foliar nutrition, fruit quality, sugars and organic acids
CAN MINERAL ANALYSIS BE USED AS A TOOL TO PREDICT ‘BRAEBURN’ BROWNING DISORDERS (BBD) IN APPLE?

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The mineral conditions of apple fruit can be used to predict some physiological disorders such as ‘bitter pit’ and several researchers have related mineral content to other internal physiological disorders found in stored apples. However, inner flesh browning prediction models developed within a given year, are specific for that year, and often are not valid for application in different years, thus repeated sampling and research is necessary in every season. ‘Braeburn’ apples frequently show physiological disorders during controlled atmosphere storage in which apples from different orchards or years or site conditions can vary considerably in their sensitivity. The aim of this research was to evaluate the relationship between the mineral status of fruit before, and at-harvest and correlate this with the Braeburn Browning Disorder (BBD) incidence found in ‘Braeburn’ apples post storage and to investigate possible reasons for differences in disorder sensitivity. Fruit from seven orchards in the Bodensee region (Germany) were harvested at two picking dates and the mineral concentrations measured before, at-harvest, and after storage. Fruit were stored at 1.5°C under CA conditions (1kPa of O₂ and 0.5 kPa of CO₂) using either a rapid or delayed establishment of CA conditions (delay of 10 to 24 days). Fruit were evaluated after two, four, and six months of storage and the browning disorder incidence related to the mineral analysis before and at-harvest. Results indicate a significant correlation between BBD with K, and the K/Ca ratio and in some cases also for Ca and P. During storage the mineral concentration in the flesh of ‘Braeburn’ apples did not change.

Keywords: fruit quality, physiological storage disorders, post-harvest, prediction
SOIL CALCIUM APPLICATION AND PRE-HARVEST CALCIUM AND BORON SPRAYS ON MANGOSTEEN FRUIT QUALITY

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Mangosteen (Garcinia mangostana L.) is susceptible to translucent flesh disorder (TFD) and gamboge disorder (GD). Both are apparent only on the fruit’s flesh making external visual inspection impossible. The importance of soil calcium application and pre-harvest Ca and B sprays on these disorders were investigated in an experimental plot in Chantaburi, Eastern Thailand. The soil was Typic Paleudults with sandy clay loam texture. Five treatments were applied to the mangosteen to investigate the relationship between nutrient concentration and incidence of TFD and GD. These treatments are 1) no treatment (control), 2) soil Ca only, 3) soil Ca and Ca spray, 4) soil Ca and Ca + B spray, and 5) soil Ca and B spray. Soil Ca was applied once as gypsum at 4 kg/tree in September 2004. The Ca spray was applied six times in 2005 and three times in 2007 using 2% CaCl$_2$·7H$_2$O. The B spray was applied three times each in 2005 and 2007 using 0.25% solubor.

The fruit samples were harvested in the middle of May of 2005 and 2007. At harvest, the fruits were separated into three groups based on their size: small (<60 g), medium (60-90 g) and large (>90 g). Then, they were classified as normal fruits, TFD fruits, or GD fruits. The concentrations of K, Ca, and B in the flesh, rind and peduncle were analyzed. It was found that the soil Ca application—with or without foliar sprays—significantly reduced the number of TFD. However, the Ca concentration in the flesh did not differ significantly between normal fruits and TFD fruits. Instead, we found that the ratio of K/Ca in the flesh is a good indicator of TFD. The study revealed that high K/Ca ratio led to more TFD in mangosteen. In general, flesh Ca decreased with fruit size while flesh K increased. As a result, larger fruits tend to have more TFD than smaller ones. When soil Ca was applied, the number of GD was significantly lower than the control. The soil Ca treatment became even more effective when combined with B spray or Ca + B spray, particularly the latter. However, treatment of soil Ca together with Ca spray did not reduce GD considerably. Furthermore, it was found that the nutrient concentrations in all parts of GD fruits were not measurably different from normal or TFD fruit. However, it was clear that Ca + B spray along with soil Ca treatment effectively reduced the number of GD. On the other hand, an excessive amount of Ca treatment without the complement of B did not lower the amount of GD fruit. We recommend that soil Ca together with pre-harvest spray of Ca + B is useful for reducing the number of TFD and GD fruits.

Keywords: gamboge disorder, Garcinia mangostana L., potassium, translucent flesh disorder
COMBINATION OF NITROGEN SOURCES IMPROVES PHYSIOLOGICAL EFFICIENCY AND FRUIT YIELD IN BANANA CV. NEYOPOOVAN (AB)

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Nitrogenous fertilizers in different form viz., urea, ammonium sulphate (AS) and calcium ammonium nitrate (CAN) were fed to banana cv. Neypoovan (AB) to assess their impact on physiological efficiency, plant nutrient status, biochemical changes and the resultant fruit yield. The nitrogenous fertilizers were applied to the plants as soil application in addition to the recommended dose of phosphorus as single super phosphate and potassium as muriate of potash. We imposed seven treatment combinations comprising soil application of 100% urea (T₁), 100% AS (T₂), 100% CAN (T₃), 25% urea + 75% AS (T₄), 50% urea + 50% AS (T₅), 75% urea + 25% AS (T₆), 25% CAN + 50% urea + 25% AS (T₇) and 25% CAN + 25% urea + 50% AS (T₈). The fertilizers were applied in split doses during 3rd, 5th and 7th month after planting. The observations recorded at the stage of shooting exhibited significant changes in the growth attributes due to fertilizer treatments. Application of 25% CAN + 25% urea + 50% AS resulted in increased pseudostem height (3.28m), girth (68.1cm) and leaf area index (3.84). The improvement in leaf area coupled with higher chlorophyll content (1.92mg g⁻¹) and SPAD value (46.7) favoured the plant to have higher photosynthetic efficiency. Chlorophyll fluorescence (Fv/Fm) was recorded high (0.827) apart from solute protein, the indirect measure of RuBP carboxylase activity. Combination of nitrogenous fertilizers improved the leaf nitrogen (N) status (1.96%) while the potassium (K) status was found unchanged. Higher leaf N facilitated the plants to have better nutrient use efficiency (32.18) and improved nitrate reductase activity (892.62µg NO₃ g⁻¹ h⁻¹) resulting in enhanced protein synthesis in the plant. The functional changes related to the physiological efficiency and biochemical characters of the plant resulted in higher bunch weight (12.86kg) and fruit quality in terms of sugar (26.54%) and TSS (23.85 °brix). The impact of residual N on ratoon (R₁) crop is also under study.

Keywords: banana, fruit yield, N sources, physiology
THE EFFECT OF PRE-STORAGE APPLICATION OF CALCIUM CHLORIDE ON CHILLING RESISTANCE AND CALCIUM CONTENT OF ‘MALAS SAVEH’ POMEGRANATE FRUITS

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The effect of pre-storage application of calcium chloride on chilling resistance and calcium content of arils and peel of pomegranate (Punica granatum) cv. Malas Saveh were determined. The fruits were immersed in distilled water and two calcium chloride concentration (135 and 270 mM) for 5 and 10 minute. The peel calcium content of treated fruits significantly increased after 2 month storage, but the arils calcium content was not affected with different treatments. After 2 month storage chilling injury symptoms were appeared. Post harvest calcium chloride treatment limited the intense of peel chilling injury symptoms such as browning and pitting but it had not significant effects on internal symptoms especially on segment separating thin layer browning. Treated fruits with 135 and 270 mM calcium chloride reduced the ion leakage of peel up to 13 and 17%, respectively.

Keywords: calcium chloride, chilling injury, ion leakage, pomegranate
EFFECT OF FERTILIZATION AND TRAINING ON THE SENSORY PROPERTIES OF KIWIFRUIT IN ORCHARDS IN NORTHERN PORTUGAL

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In our latitude, expectations of the kiwifruit sector regarding kiwi productions with high yields and an adequate fruit size have been fulfilled. Thus, at present, this sector is focusing their efforts towards the quality improvement of fruit sensory properties, highly demanded by the consumer, so as to be competitive in the international market. There are several sensory properties that determine quality in kiwifruit. A kiwifruit is considered to have a good flavour quality standard, when the content rate of soluble solids (°Brix) is the highest when consumed. Dry matter is another parameter internationally accepted as an indicator of the "intrinsic" quality of kiwifruit. The acidity and the starch content also play an important role on the attainment of these quality standards. The aim of the present work is to determine the effect of fertilization and training (T- bar or pergola) on content and evolution of these sensory parameters. Assays were performed during 2007 in kiwi orchards in Northern Portugal (Kiwí Ibérica S.A.), taking fruit samples every 15 days from fruit set (phenological stage H) until harvest. Then, sensory properties of these fruits were analyzed according to AOAC internationally recognized methods. Results showed that fertilization influenced significantly on dry matter, soluble solids, starch content and acidity. Significant differences were also observed between both training systems during the first stages of fruit development; but these differences disappeared in later stages until commercialization.

Keywords: dry matter, °Brix, starch, acidity
ROOT ENDOPHYTIC FUNGI ON AVOCADO (PERSEA AMERICANA MILL.) BORON NUTRITION: EFFECT ON CV. HASS PLANTS ON AN ANDISOL

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Since early phases in the evolution of root systems of plants, endophytic fungi played a role for plant nutrient acquisition. Plant health and soil fertility might be improved by the application of selected mycorrhizal inocula, although their usefulness on field conditions is under debate. Avocado plants are obligatory associated with root entophytic fungi (REF) under field conditions, although their contribution to nutrient uptake is largely unknown in this species. In comercial orchards avocado cv. Hass grafted onto a mexican rootstock is always associated with fungal endophytes. Their role in boron nutrition of Hass avocado was studied on an andisol from Michoacan, México. The effect of mycorrhizal roots on boron accumulation in different plant parts, on stem firmness and on soluble boron in soil was evaluated. Treatements were derived from a factorial 3 x 3 experiment with the following factors: inocula, 1 = indigenous root endophytic fungi (EN), 2 = Glomus intraradices (Gi) and 3 = endophyte free plants (T); and supply of soluble boron: low = 0.13 (original soil concentration), medium = 0.25 and high = 0.50 mg.kg⁻¹ of dry soil. Medium and high treatments were completed with boric acid. Results showed that: i) indigenous endophytes inoculation from this orchards raised total plant boron contents; ii) Glomus intrarradices inoculum had no evident effect on boron accumulation and iii) there are statistical differences as independent factors for total boron and for inoculum type, but its interaction was not significant. The contribution of REF on boron absorption could not be yet ascertained. Further research on the role of REF is required due to: 1) plants that grew 6 months on a deficient boron soil with indigenous root entphytic fungi did not showed any boron deficiency symptoms, 2) when soil was inoculated with indigenous root fungi, total boron increased after one year and also increased soluble boron concentration in the soil, 3) boron deficient plant stems were weaker and, 4) REF increase the stem firmness of boron deficient plants.

Keywords: avocado, boron, Glomus intrarradices
RELATIONSHIP BETWEEN SOIL AND LEAF POTASSIUM CONTENT AND ‘VALENCIA’ ORANGE FRUIT QUALITY

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In order to evaluate the relationship between orange fruit quality and potassium concentration in soil and leaves 30 plants of 20 year old ‘Valencia’ orange grafted on ‘Cleopatra’ mandarin were evaluated in Nirgua, Yaracuy State, Venezuela. For each plant 12 samples of 12 fruits each were analyzed. It was determined polar and equatorial diameter, fresh mass, shell thickness and percentage, juice percentage, total titratable acidity (TTA), total soluble solids (TSS) and Ratio; In addition, samplings of soil and leaf were taken for potassium analysis. After verifying the data normality, it was calculated the correlation, between potassium in the soil and the fruit quality attributes, obtaining significance for the peel and juice percentage. When considering leaf potassium it was found significance for fresh mass and shell percentage, TTA and TSS. It was found that with greater potassium level orange fruits have lower fresh mass and juice content; and higher shell proportion, TTA and TSS

Keywords: Citrus sinensis L. Osbeck, relationships
THE EFFECTS OF CA APPLICATIONS ON PEACH FRUIT MINERAL CONTENT AND QUALITY

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Late season peach cultivars are usually cold stored for a few weeks to extend the marketing season, but physiological disorders related to calcium deficiency are now emerging. To study the absorption of Ca by the peach fruit, adult trees of two late maturing cultivars: ‘Miraflores’ and ‘Jesca’ have been treated with Ca applied in two different ways: either the trees were sprayed with 0.25 to 1% Ca water solutions, or the fruits were rubbed with a Tara gum gel containing Ca at 0.5 or 1% concentration. In both cases, the Ca source was CaCl2. In experiment 1, repeated foliar sprays along the growing season, of aqueous solutions of Ca concentrations ranging from 0.25 to 1% Ca promoted non-significant increase in the concentration of Ca in the peach skin, while little effects were found on the fruit flesh. However, by harvest a great decay in Ca concentration in the peel occurred and no differences among treatments were observed. Conversely, no effects on the fruit quality traits were observed at harvest. In a second experiment, fruits were smeared with a calcium containing gel. A great increase in Ca concentration was found both on skin and flesh of fruits treated with 1% Ca. However, fruits treated with 1% Ca had a greater preharvest drop than the other treatments, and some fruit quality traits at harvest were affected, as flesh firmness which was smaller on both sides of the fruit, and fruit shape, which became more flat.

Keywords: Ca absorption, calcium, fruit physiopathies, fruit quality, peach, Prunus persica.
EMULSIFIED NUTRITIVE FLUIDS AND THEIR PROPERTIES CONTROL

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A new approach of the foliar nutritive fluids formulation as emulsions and their properties design was grounded on the last illuminations in the mechanism and kinetics of the foliar nutrition. Emulsified organic and inorganic phases are bearing extended multifunctional biological activities – nutrition, growth enhancing and fungi repelling. Selection of the overbasic potassium salts of naphthenic and oleic acids as organic phase carrier entrusted leverage control of the foliar required properties through their overbasicity, hydrolysis and hydrolysis pH, as well as through the mixed organic/inorganic hydrolysates particle size distribution inside the film formed at the foliage surface. Aqueous phase may accommodate variable formula of NPK macronutrients and regular contents of micronutrients under suited restrictions called by the emulsion stability. Due to the both phases reactivity, at the foliage level the diluted fluid leaves a matrix made up by organic hydrolysates, grafting the entire mineral charge as an amorphous phase ready to dissolve at high rate. All new born biological active entities are released by organic matrix as nanoparticulate amorphous matter, as well as micelles charged with amorphous nanoparticulate at a rate close to plant demands, preventing overdosing and eventual plant harms. All nutritive fluid components are biodegradable or non harmful for environment. The sorption mechanism-property correlations are illustrated by property-composition diagrams, pH monitoring during organic matrix precipitation and reaction with air carbon dioxide, and dynamic particle size distribution in hydrolyzing emulsions.

Keywords: foliar, fungicide, growth enhancing, nutrition
FOLIAR ECOLOGICAL PRODUCTS EFFECT ON
APPLE GROWTH, YIELD AND QUALITY

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This paper discloses a new class of foliar nutritive fluids with multiple biological functions, whose core components are the micelle overbasic metallic naphthenates, accompanied in all formulations by the common nutrient elements found in liquid fertilizers. Active primary raw components and additives have been selected according to the ecological requirements for this type of products. Four commercial brands have been formulated to provide appropriate amounts of nutrients at the convenient uptake rates according to the stage of crop development. Taking over unusual overbasic potassium naphthenate physical and chemical attributes, some new properties adequate to the foliar nutrition were investigated and tied up to foliar products with defined purpose to improve their fertilizing, fungicide and growth enhancing functions. The field experiments were designed in 5 treatments linearly located and 4 replications with the apple trees cv. as factor A, ecological product application as factor B and the moment of application as factor C. Foliar application of ecological products has induced a shoot growth of about 25% in the ‘Jonathan’ cv., respectively 30% in ‘Idared’ cv. and of 15% in ‘Golden Delicious’ cv. Fruit yield in the 3 apple varieties cvs. was significantly increased versus the control treatment. The ecological products had also a good effect on the fruit quality (means weight, firmness and color) and protect crop against storage diseases after harvesting. Products do not change either the chemical composition nor the taste or flavor of the treated apple fruits.

Keywords: ecological, apple, foliar, growth
Green and blue moulds, due to the pathogenic action of *Penicillium digitatum* and *Penicillium italicum*, respectively, are the main cause of orange losses during postharvest. In Mediterranean climates both together are responsible for 80% of total postharvest citrus fruit decay. The orchard production system, field location with different climate and soil has a main influence on fruits mineral composition. The fruits mineral composition can have a significant impact on fruit quality and shelf life during postharvest period. These include effects on fruit colour, texture, disease susceptibility, juice composition and physiological disorders development. In this study oranges from different origins (south of Portugal and southeastern of Spain) and from three production systems (conventional, integrated and ecological) were studied. The hypothesis was if both factors (origin and production system) affected the fruit sensitivity to decay. Fruits were wounded and inoculated with *P. digitatum* or *P. italicum* at 10^6 spores/ml. Decay incidence was monitored after storage at 20ºC for 7 days.

For mineral composition, the peel of the fruits was dried at 60 ºC for 48 h, grounded, ashed at 450 ºC, and digested in 10 cm^3 HCl 1 mol dm^{-3}. Standardized procedures (AOAC, 1990) were used to determine nutrient concentrations: nitrogen was analysed by the Kjeldahl method, phosphorus was determined colorimetrically by the Molybdo-Vanadate method, potassium was measured by flame photometry, and Mg, Ca, Fe, Cu, Mn and Zn were measured by atomic absorption spectrometry. Results will be discussed considering the relation between the disease incidence and fruit mineral composition.
EVALUATION OF FE DEFICIENCY EFFECTS ON ANTIOXIDANT ACTIVITY OF STRAWBERRY FRUITS

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The effects of Fe deficiency on the antioxidant properties of strawberry juice was carried out with a day-neutral cultivar ‘Selva’. Bare root transplants (without leaves) with approximately 18 cm, were transferred to Hoagland’s nutrient solution, using Fe-EDDHA as the Fe source, at three different concentrations: 0, 2.5 and 5 µM Fe. Plants were grown in 20 L containers in a glasshouse for 6 weeks (from April 27 to June 5) under natural photoperiod conditions and air temperature ≤ 25 ºC. Twelve transplants were used per treatment distributed in a complete randomized design. Plants grown in absence of Fe revealed chlorotic symptoms approximately after three weeks, based on SPAD values in young leaves (≤20). The other treatments did not show any symptoms during the experiment. Fruits were harvested from each treatment, and juice was analysed for antioxidant activity by using the trolox equivalent antioxidant capacity (TEAC) and oxygen radical absorbance capacity (ORAC) assays. In addition, fruits were analysed for total phenols and ascorbic acid contents.

The phenolic content varied between 1250 and 1500 mg gallic acid equivalents (GAE) L⁻¹ juice, but with no significant differences. Significant positive correlations were found between SPAD values and the antioxidant activities. It was found that Fe deficient fruits reduced significantly the ORAC values of strawberry fruits, varying between 27 in Fe deficient fruits and 48 µM TE mL⁻¹ in fruits from plants grown with 2.5 µM Fe. The TEAC values, expressed by the mean effective concentration (EC₅₀), demonstrated a significant negative correlation between the ascorbic acid concentration and antioxidant activity, on the other hand revealed a significant positive correlation with the total phenols concentration. This result reveals that the high antioxidant activity is due to the ascorbic acid concentration and not the phenolic content.

Keywords: antioxidant capacity, ascorbic acid, Fe deficiency, ORAC, strawberry, TEAC

Acknowledgements: This work was supported by the project PTDC/AGR-ALI/66065/2006
EFFECTS OF SLOW RELEASE FERTILIZER ON CITRUS CLEMENTINE FRUIT YIELD AND QUALITY

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A field experiment on a commercial citrus orchard was carried out with mature trees of Clementine (Citrus reticulata Swingle). The tree received the same fertilization amount but by two different fertilization methods. On one plot of half hectare the trees were fertilized with a slow release fertilizer composed with (17N-12P-18K +2Mg) buried 10 cm dip at the beginning of the spring tree flush growth (first week of April). A second supply was made at the beginning of autumn tree flush growth (end of August) with another composition of the slow release fertilizer (13N-5P-27K +2Mg). On another plot, the trees were fertilized with the same quantity using the drip irrigation system and well distributed during all the season growth.

The aim of this work was to study tree responses to the two fertilization methods. The result shows that shoots grew faster with the slow release fertilizer than with fertigation. However fruit growth was similar between the two treatments.

At harvest fruit yield and quality were also evaluated. Fruit weight was not affected but the solid soluble percent was higher with the slow release fertilizer.

Keywords: citrus, quality, slow release fertilizer, yield
MINERAL NUTRITION OF PEAR AND APRICOT TREES CULTIVATED IN SOUTHERN-ITALY AREA DAMAGED BY PHYTOPLASMA MICRO-ORGANISMS

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The aim of this research was to investigate the eventual relation between the leaves mineral nutrition and the susceptibility of the plants to phytoplasma infection. Furthermore, the chemical fertility of soils was determined to understand if it was correlated to unbalanced mineral nutrition of the trees. The study on the mineral nutrition of the trees was carried out on samples collected in orchards infected, from 1995 to 1998, by ‘Candidatus phytoplasma pyri’ and by ‘Candidatus phytoplasma prunorum’.

Apricot and pear were cultivated in areas far 10 metres each other. Soils and leaves were collected in July 2006. Soils were air dried and screened through a 2 mm sieve, and analyzed for chemical and physical characteristics. The soils and leaves samples were extracted and analyzed for the macro- meso- and micro-nutrient contents such as nitrogen (Kjeldahl method), phosphorus, potassium, calcium, magnesium, sodium, iron, copper, manganese and zinc (by Inductively Coupled Argon Plasma Spectroscopy -ICP).

The results show a sub-acid pH value in the pear orchard soil and a acid pH value in the apricot orchard soil.

The Cationic Exchange Capacity and the concentration of Sodium and magnesium are in the mean instead the available potassium is abundant.

In all soil samples, the total nitrogen and the organic matter are present at medium concentrations. The heavy metals, either total or bio-available, are not in excess in the soils.

The test on the leaves samples showed the imbalance of the ratio K/Mg with consequent lack of Mg, in the apricot, and the imbalance of the ratio Fe/Mn with evident lack of Mn, in the pear.

Keywords: apricot, chemical fertility, mineral nutrition, pear, phytoplasmas

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EFFECT OF BORON SUPPLY ON SOME ASPECTS OF APPLE FRUIT QUALITY

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In the past times, Boron has been used in experimental fruit crops to improve post-harvest quality of fruits, inducing a significant Calcium intake, so enforcing the strength of cell walls, and a consequent longer shelf-life.

The present work examined the effect of a Boron fertilization (1kg/ha, upper limit of Italian rule) on the quality of 13 commercial apple varieties (Braeburn group, CTIFL and Hillwell, Fuji group, Brasileira, Kiku 8 and Naga-Fu 6, Golden group, Golden B and Smoothee, Granny Smith and 5 scab-resistant, Baujade, Golden orange, Harmonie, Red Early and Summerfree) and 6 old apple varieties (Calvilla Bianca, Pomme Cloche, Pom Fer, Rambour Franc, Regina delle Renette and Renetta Ruggine) cultivated on plan in an experimental field (Lodi, Italy).

Fruits were harvested in 2006 in two or three commercial harvest times, separated by one week. Besides, fruits were stored at 0-1°C for three months. Analyses were carried out at the harvest time and after storage on a sample of twenty fruits for each lot.

The analyses regarded the main quality parameters (weight, colour, firmness, sugar and starch, titratable acidity, vitamin C and total polyphenols).

Generally, confirming previous results, fruits subjected to Boron showed earlier ripening indexes (higher yellow index of the skin colour, lower firmness, lower starch content and higher free sugar content). The fruit weight was also increased by Boron supply. The content of antioxidants, expressed as vitamin C and total polyphenols, decreased by Boron supply, except for polyphenols flesh content after storage, confirming previous results regarding the higher storability of Boron-fertilized apples. The significance of differences was not evidenced for all varieties, suggesting a different response depending on the genotype.

Keywords: apple, boron, quality.
OBSERVATIONS ON THE MINERAL ELEMENTS ANNually UPTAKE BY THE YIELDING OF HAZELNUT ORCHARD

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In one of the most important Italian hazelnut cultivation area (Langhe district, Piedmont) in 2 orchards the yielding were recorded and a nut sample were taken for determination of major and minor elements contents.

The data show that the fruit mineral composition is rather variable between orchards and especially years.

As expected the main quantity of extracted elements were Nitrogen (about from 8 till 30 kg/ha/year) for the major and Iron (about from 20 till 140 g/ha/year) for the minor elements. These results could be very interesting to estimate the quantity of mineral fertilizers to supply annually to the hazelnut orchard.
INFLUENCE OF NITROGEN AND MAGNESIUM FERTILIZATION OF OLIVE TREE CV. PICUAL ON YIELD AND OLIVE OIL QUALITY

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Ribatejo is a traditional producer of olive oil region of Portugal, being Picual one of the first Spanish cultivar used in intensive olive groves. In this region, a field experiment was established in order to study the influence of nitrogen and magnesium application on fruit-yield, fruit characteristics and some quality parameters of olive oil. The olive grove was planted in 1987 on a Calcaric regosol and was managed under dry conditions. Three levels of nitrogen (0, 60 and 120 kg ha⁻¹ N) and magnesium (0, 18 and 36 kg ha⁻¹ Mg) were used, arranged into a factorial experiment with three replications. Nitrogen and magnesium were applied annually to the soil since 1995, as ammonium sulphate and magnesium sulphate, respectively. Experimental results obtained from 1995 to 2004 show that the fertilization influenced the fruit-yield, water-fruit content and fruit-fat content, with a significantly mean effect (p≤0.05) of the interaction N x Mg for the two first parameters. The higher fruit-yield was obtained with 60 kg ha⁻¹ N and 36 kg ha⁻¹ Mg, whilst the fruit-fat content decreased with nitrogen application. The index of maturity, the fruit-mean weight and the evaluated quality parameters of olive oil (acidity, peroxide value, specific absorbance coefficients K₂₃₂ and K₂₇₀ and oxidative stability) were not significantly affected (p>0.05) by fertilization.

Keywords: fertilization, Olea europaea L., olive oil quality, yield
THE EFFECT OF NUTRITIONAL BALANCE AND PLANT PROTECTION ON THE DECREASE OF FLORAL BUD ANOMALIES IN *OLEA EUROPaea L.*, CVs ‘CONSERVA DE ELVAS’ AND ‘SANTULHANA’

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Two field experiments were performed in order to evaluate the influence of a rational fertilization and adequate phyto-sanitary treatments on the floral anomalies of olive tree cultivars ‘Santulhana’ and ‘Conserva de Elvas’. The experiments were carried out in the portuguese regions of Trás-os-Montes (Mirandela) and Alentejo (Elvas). The fertilization included the application of nitrogen and boron in cv. ‘Conserva de Elvas’ and nitrogen, magnesium, zinc and boron in cv. ‘Santulhana’. The plant protection treatments were applied in order to prevent *Spilochaea oleaginea* Cast. Hughes and *Colletotrichum spp.*, and to control *Bractrocera oleae* Gmel incidences. The quantification of lesioned floral buds was carried out before full bloom on samples of buds picked from each experimental plot observed by stereomicroscopy, light and transmission electron microscopy. To evaluate the nutritional status of olive trees, leaf-samples were collected annually at endocarp hardening and at rest winter. Experimental results obtained in 2004 and 2005 showed that the floral bud lesions were associated with the presence of amoeboid protists. The deeper lesions can lead to the blockage of flower development. Fertilization and phyto-sanitary treatments led to a decrease of the percentage of floral bud bearing anomalies. These cultural practices joined together amplified the effect and led to a higher fruit-yield.

Keywords: cytology, flower bud lesions, mineral nutrition, plant protection
EFFECT OF NITROGEN FERTILISATION LEVELS ON SUSCEPTIBILITY OF PEACH TREES TO PHOMOPSIS AMYGDALI IN A FIELD TRIAL

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The effect of different levels of nitrogen fertilisation on the susceptibility to peach constriction canker, caused by Phomopsis amygdali, was studied in a field trial, from March 2005 to April 2008. The orchard was established at April 2001, and this trial was carried on Rich Lady cultivar. Four different nitrogen levels were used: N0 – without nitrogen, N1 – 50 kg N/ha, N2 – 100 kg N/ha, and N3 – 200 kg N/ha.

Plant inoculations with P. amygdali were carried out in November. The canker length at inoculations sites was measured between January and March of the following year and used as susceptibility assessment.

Twenty-five leaves per tree were sampled in June of each year to obtain an early diagnosis of the nutritional status of the trees. Yield and fruit quality – hardness, total sugar content and acidity – was evaluated.

The results show that after three years of different fertilisation, N0 plants didn’t present low nitrogen foliar content and there were similar constriction canker susceptibility as well as yield.

Keywords: integrated production, peach tree, Phomopsis amygdali, plant nutrition, nitrogen fertilisation
THE PHYSIOLOGICAL AND BIOCHEMICAL RESPONSE OF THE RESISTANT AT DISEASES APPLE VARIETIES ON MINERAL NUTRITION

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Depending on the mineral resources, the nutritional status of the apple trees, host plant species and type of pathogen, mineral nutrition might affect resistance or tolerance at diseases. The effects of mineral nutrition on apple trees and yields are usually explained in terms of the function of these elements in plant metabolism.

In the same time with the introduction in cultivation of the resisting varieties, it is imperative to study the causes that can lead to reduction or even to the growth of the resistance at diseases of the apple trees, respectively the resistance at Venturia inaequalis and Podossphaera leucotricha.

Knowing the fact that nitrogen, applied in various forms and quantities, can reduce the trees resistance at disease, this work intents to present the influence of the fertilization regarding the apple varieties resistant at diseases or, more precisely their response, by physiological and biochemical point of view, at the impact with fertilizing elements.

For this purpose, we have conducted experiments with 3 apple resisting varieties created in Romania: Generos, Voinea, Pionier, compared under all the aspects with a common variety: Jonathan.

Starting from the nutrition requirements of the trees, these ones have been administrated with N,P,K fertilizer, in various quantities and in various moments of the trees life cycle. It has been followed the influence of each of these elements (in special N) on the vegetative growths, on the biochemical composition of fruit, on the production and the resistance at diseases.

The problem of the loss of the resistance at diseases must be considered as a perpetual competition between the host plant and the pathogenic agent, in which the different conditions of fertilization may influence the position of one the two parts.

Keywords: diseases, nutrition, resistance
INTERACTIONS BETWEEN SOME QUALITY PARAMETERS WITH NUTRITION STATUS OF APRICOT

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Apricot tree is one of the termophile species fruit – tree and is cultivated in the south – east of Romania, where there is Research Development Station for Fruit Tree Growing Baneasa Bucharest. The quantity and quality of the apricot products is in connection with the nutrition conditions of the plantation. Both, the deficit and the fertilizers excess may be dangerous for the plantation and the fruit products, such as: the absents of the nutritive substances causes weak growth of the trees and low fruit products; the fertilizers in excess, trees sensibility given the sever frost and the attack of pathogenic agents; it is favors vegetative growth in prejudice of abundant fructification; there are residual accumulation in the soil and fruits. For that is necessary a well – balanced nutrition of the soil and ecological protection of product and environment. In this study are presented the results regarding on optimum condition of apricot species cultivated at Research Development Station for Fruit Tree Growing Baneasa Bucharest.
YIELD PATTERNS CALL INTO QUESTION MECHANISM OF ALTERNATE BEARING AND EXPERIMENTAL DESIGN IN PISTACHIO (PISTACHIO VERA)

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Many fruit and nut crops fluctuate between an ‘on’ year of high yields followed by an ‘off’ year of low yields, a behavior called alternate bearing. Although this behavior is documented at the branch scale and orchard scale, due to the difficulty in harvesting individual trees, alternate bearing has not been adequately tested at the scale of the entire tree and little is known about the spatial relationship of yields between trees in an orchard. Recent precision harvesting advances has facilitated the collection of 4,000 – 10,000 individual tree yields over six years in a mature Pistachio orchard. Results confirm that there is a general high degree of alternate bearing but a large majority of trees do not always alternate in the prescribed one year ‘on’, one year ‘off’ pattern, every two years. Some time periods show dramatically greater levels of alternate bearing than others. Moreover, results demonstrate that there is a high degree of spatial relatedness of yields but the pattern and degree of relatedness is inconsistent across all the years. These findings (i) call into question the notion that bud abscission and resource limitation cause alternate bearing in Pistachio and (ii) illuminate issues of experimental design in Pistachio and other orchard crops.

Keywords: Alternate bearing, autocorrelation, experimental design, spatial analysis
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