

Symposium 10 (S10): Sustainability of Horticultural Systems in the 21st Century—Global Issues, Problem Areas, Systems Design, Stewardship of Resources, Climate Change, Sustainable Cropping Systems, and Ecological Economics

Monday · August 12

Location: Metro Toronto Convention Centre, Room 104C

**1100–1120
INTRODUCTION**

**1120–1200
S10-0-1
APPROACHING SUSTAINABILITY: TOWARD A NEW FRAMEWORK FOR HORTICULTURE EMBEDDED IN SOCIETY**

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In the beginning of the 21st century the development of the agricultural and horticultural sector in most of the modern industrialized countries continues to follow the main directions that have already been laid down, but in doing so it is influenced and challenged at the same time by a number of factors in a wider social, economic, ecological and geographical context. The key elements in this autonomous development, besides the ongoing integration in society, are the horticultural sector's strive for an equal development in economic and social terms and the impact of the ongoing technological development. An accelerating globalization and liberalization of horticultural production and trade will affect it. This seems to give the big multinational chains a free hand for a unilateral optimization of economic progress, facilitated by technological progress and rapidly transferable knowledge. The increasing awareness of the need for a license to produce, however, leads to a balanced strategy, in which not only economy (profit) but also ecology (planet) and the norms and values of technology and society (people) have a place. This 'triple bottom line' or 'socially responsible entrepreneurial activity' proves to be a generally new three-dimensional framework for further development in all branches of industry, including Horticulture and agriculture. It will have big consequences for operating of all the actors in de total cluster. This new framework which can be used as a tool for guidance in organizing and developing horticultural science and technology, is elaborated in this contribution.

**1200–1220
S10-0-2
A CASE STUDY OF CHALLENGED SUSTAINABILITY: INFLUENCE OF CLIMATIC TRENDS ON LATE BLIGHT EPIDEMIOLOGY IN POTATOES**

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A new aggressive genotype of *Phytophthora infestans* (US8, A2 mating type, phenylamide-insensitive) the cause of potato late blight, has replaced the clonal lineage that predominated in North America up until 1995. Sustainability of potato production has come under pressure for the following reasons: potential loss of effective pest control measures, e.g., for late blight; reduced availability of agricultural land resulting in production of monocultures in limited geographic regions; and indications that conditions may be becoming more conducive for pest survival. In addition, economic pressures have increased on growers to produce higher yields with consistent tuber quality. Late blight is temporally sporadic in potato crops in Midwest U.S., occurring only when microclimate conditions within canopies are favorable and inoculum is present. Increasing concern over climate change projections has prompted numerous crop-based studies on the possible agricultural implications. It is not possible to evaluate sustainability without understanding the interactions between the influence of climatic trends, host resistance, cultural interventions and fungicide efficacy in relation to late blight risk. Analysis of historical data from 1948–99 indicated that late blight risk

over a standardized growing season from 1 May–30 Sept. increased in the Upper Great Lakes region of the U.S. Host resistance options are limited however significant progress has been made to introduce less susceptible potato cultivars into the system that require less intensive crop protection measures. As conditions become increasingly favorable for late blight development it is essential to reduce sources of initial inoculum through integrated approaches that include prediction of conditions conducive to late blight development and appropriate application of controls.

**1220–1240
S10-0-3
A CASE STUDY OF A POTENTIAL SOLUTION FOR CHALLENGED SYSTEMS' SUSTAINABILITY: APPLICATION OF PRECISION FARMING IN TREE CROP PRODUCTION**

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The widespread adoption of precision farming techniques in field crops is in stark contrast to the situation for tree crops in which broad scale application of precision farming techniques is in its infancy. The high value of tree crops, their longevity and the high cost of inputs suggests that the application of precision farming to tree crops would be of great value. The application of precision farming techniques to tree crops has the potential to dramatically alter management techniques and to profoundly influence how we conduct statistically valid research. It provides a powerful new tool for the identification of superior genetic material. As a whole, precision farming may be a technique to develop more sustainable production systems by allowing for a more effective identification of genetic material with a higher productive potential and of production and management techniques, that make more efficient use of resources and that more effective. Here we describe the implementation of a large scale precision farming project conducted in an 100 acre block of mature Pistachio. In this project individual tree yields were obtained in each of 10,000 individuals, additional determinations included of soil mapping of ECe, soil textural characteristics and moisture at 1 meter intervals, aerial multispectral analysis and leaf sampling. GIS and multivariate analysis was then used to interpret the data and design management strategies. Results verify the significant effects of local environmental variables on yield and have helped identify individual trees with profoundly superior productivity. New statistical approaches and decision management tools for the application of precision farming to tree crops for supporting more sustainable production systems will be described and discussed.

**1340–1440
S10-P-4
DIFFERENTIAL INSECTICIDE EFFICACY FOR CONTROL OF ROOT WEEVILS ON EUONYMUS**

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In June 2001, adult stages of black vine (*Otiorynchis sulcatus*) or strawberry (*Otiorynchus ovatus*) root weevils were established in 2.7 liter containers of Euonymus 'Emerald Gaiety' in a randomized complete block design (n = 15). Insecticides were foliar-applied, and efficacy was evaluated as percentage of adult mortality and effective kill ratio (EKR) 14 days after treatment. The EKR adjusts the data for the natural mortality of weevils in nontreated pots, assigning an EKR of 0 to nontreated pots. An EKR of at least 21 was needed to be significantly different from nontreated pots. Adult mortality and EKR was higher for black vine compared to strawberry root weevil for all insecticides studied. Acephate, acetamiprid, azadiractin, bifenthrin, deltamethrin, kaolin film, lambda cyhalothrin, pyrethrum, and thiamethoxam provided an EKR of 14, 40, 33, 38, 53, 35, 82, 9, and 20, respectively, for black vine root weevil, and 11, 17, 0, 0, 7, 12, 23, 8 and 38, respectively, for strawberry root weevil. Combining lambda cyhalothrin with thiamethoxam provided an EKR of 96 and 49 for black vine and strawberry root weevil, respectively. Lambda cyhalothrin alone or in combination with thiamethoxam provided acceptable control of black vine root weevil (EKR > 80), while none of the insecticides studied provided acceptable control of strawberry root weevil. Reduced damage from foliar feeding by root weevil adults suggests that mortality from kaolin film application was caused by inhibition of feeding.

1340-1440

S10-P-5

GIS AS A TOOLS TO AGROCLIMATOLOGICAL ZONING OF AZARBAIJAN PROVINCE FOR DRYLAND FARMING OF ALMOND

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Almond (*Prunus amygdalus*) is one of the stone fruits with flowering stage sooner than others. This is the most important factor causing flower and young fruits chilling injury. The amount and distribution of precipitation, Moisture Available Index (MAI) and duration of growing season are other factors affecting Almond yield. The objective of this study was the classification of Azarbaijan Sharghi Province with regard to its potential for Almond in dryland farming. For this purpose, we collected and analysed the precipitation, evaporation and temperature parameters of 11 meteorological stations and the phenological data (flowering date) as well. The indices of suitable conditions to Almond dryland farming were 1) Probability of chilling occurrence on bud and flower of Almond; 2) Probability of rainfall greater than 250 mm; 3) Spring and summer precipitation to annual precipitation ratio; 4) Probability of occurrence of growing degree days greater than 3500 G.D.D. (base temperature 0 centigrade); 5) The amount of available moisture index. The Digital Elevation Model (DEM) of the area studied has been digitized using ARC/INFO software and a digitizer. For each of above parameters a GIS map (using IDRISI software) was prepared, and afterwards the errors of each of the 5 maps were corrected. With crossing and overlapping of the 5 mentioned layers, favorable, weak and undesirable zones for Almond production were obtained.

1340-1440

S10-P-6

FIRST YEAR RESULTS OF THE IMPACT OF A NOVEL PEST MANAGEMENT TECHNOLOGY ON APPLE FRUIT QUALITY

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A new, 'reduced risk' biopesticide, kaolin, is commercially available as a potential replacement for insecticides that manage key apple insect pests. When kaolin is sprayed onto the tree, it forms a physical barrier that repels insects or makes the site unrecognizable and/or unsuitable. Initial research indicated that kaolin also might have nontarget impacts because of a reduction in heat stress. However, most of the research on nontarget effects, such as impacts on fruit quality, has been conducted in warmer, semiarid environments; a reduction in canopy temperature may not be beneficial in cooler orchard environments. One of the objectives of this 3-year study is to determine the effects of kaolin-based particle film on fruit quality. Using a completely randomized experimental design, five treatments, replicated six times will be applied yearly to the plots: 1) kaolin starting at the Silver Tip and continuing on a weekly schedule through Petal Fall, then biweekly to the end of the growing season, plus fungicides and horticultural sprays; 2) kaolin starting at Silver Tip and continuing on a weekly schedule through Petal Fall, then biweekly to the end of the growing season but trees would not receive any fungicides; 3) kaolin starting at the Petal Fall and continuing on a biweekly schedule through the end of the growing season, plus fungicides and horticultural sprays; 4) a typical IPM spray program consisting of applications of phosmet plus fungicides and horticultural sprays; and 5) a control where no insecticide (kaolin or phosmet) will be applied but trees will receive fungicides and horticultural sprays. In 2001, data indicate significant differences in the treatments in fruit weight, height, width, firmness and starch index. There were no significant differences in percent red color. This study will continue through 2004 to determine kaolin's potential nontarget horticultural impact under cooler growing conditions.

1340-1440

S10-P-7

DEMONSTRATION AND EVALUATION OF INTEGRATED CROP MANAGEMENT SCOUTING FOR PUMPKINS IN SOUTHERN NEW JERSEY

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New Jersey has about 2,300 acres of pumpkins representing nearly 400 growers. Pumpkins are an increasingly important cash crop in New Jersey, commanding a significantly greater revenue than many other row crops. The Rutgers Cooperative Extension Vegetable Integrated Pest Management Program conducted a pilot project to move towards developing a deliverable protocol for pumpkin scouting in New Jersey. In 2001, five farms were selected in Southern New Jersey to demonstrate and evaluate integrated crop management (ICM) scouting methods on pumpkins. Each farm was evaluated for soil type, soil fertility levels, soil pH, nematode populations, pesticide application records, pumpkin varieties, pumpkin yield and quality. Pumpkin diseases and insect pests were the main concerns of farmers participating in this project. Each of the five farms hosted comparison fields with ICM and non-ICM plots consisting of the same varieties on the individual farms. In the non-ICM plots growers used standard pesticide application schedules outlined in the 2001 Commercial Vegetable Production Recommendations Guide for New Jersey. ICM plots were scouted twice weekly until powdery mildew was detected and from that point on fields were scouted once weekly. Pesticide applications in the ICM plots were based on pest identification and pest levels found after scouting fields. On four of the five farms the ICM scouting results were able to reduce pesticide usage without reducing yield and quality.

1340-1440

S10-P-8

DEVELOPMENTS IN PEST MANAGEMENT FOR INTEGRATED FRUIT PRODUCTION OF APRICOT IN BULGARIA

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The apricot is one of the most cultivated crop of stone fruit in Bulgaria and is a major fruit crop particularly in Silistra province. This region is known at national and international level as an area devoted for apricot production. Integrated Pest Management strategy for the key pests of apricot trees such as *Anarsia lineatella* Zell, *Cydia* (Grapholitha) *molesta* Busck, leafrollers (Tortricidae), phytophages (*Lymantriidae*, *Arctiidae*), weevils (Curculionidae) and pathogens *Monilinia* (Sclerotinia) *laxa* (Aderh. et Ruhl.) Honey, *Gnomonia erythrostoma* (Pers. Ex.Fr.) Auersw, *Coryneum beyerinckii* (Oudem), *Alternaria tenuissima* (Fries) Wiltshire and *Pseudomonas syringae* (Van Hall) are pointed out. In recent years a better bioecological knowledge of the listed pests and pathogens have been accumulated. On this basis their control could be markedly improved by using biotechnical, agronomic and chemical methods. In general, the main protective control should be applied during the autumn-winter and early spring season when the pests overwinter on fruiting trees. The justification of treatments, by means of sampling for pests (application of economic thresholds), or of climatic conditions favourable for diseases is always required. This model provide a good coverage of the trees while leaving minimal pesticide residues on the apricot fruit. So far, the application of Integrated Pest Management program has brought about 35% reduction in the number of treatments, quantities of pesticides used and costs. The investigation aims to provide information that will allow pests to be treated at the most susceptible stage of their growth. The results of biological and chemical pesticides used in integrated production are also discussed.

1340-1440

S10-P-9

ROLE AND STATUS OF PLANTAIN IN AGROFORESTRY CROPPING SYSTEMS IN SOUTH WEST CAMEROON: WHICH PATHWAYS TO PRODUCTIVE AND SUSTAINABLE SYSTEMS?

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In southwestern Cameroon, small, family farms are traditionally based on cocoa cropping systems. Since the 1990s, farmers have faced decreasing cocoa prices and the privatisation of trade operators. Concurrently, the increased urban demand for plantain and roots has not been satisfied. Hence these crops represent an opportunity for farmers to increase their incomes. An analysis of the role and status of the crops in the cropping systems was undertaken to

provide information about trends in their use and their agronomic suitability. Current cropping patterns and historical information from 100 farms in south-western Cameroon were analyzed. 90% of farmers' plots are mixed and include a high diversity of species including perennial (cocoa, coffee, palm trees, fruit trees, etc.), semi-perennial (plantain, banana), or annual (yam, cassava, cocoyam, maize, etc.) crops. Cocoa and plantain are the most frequent crops, occurring in 81% and 74% of the sampled fields respectively. In fact, plantain is commonly used in various cropping systems after deforestation. While plantain is still traditionally used as a shade crop for new cocoa plantings, it is now also grown in monoculture for several cycles before cocoa is planted. Thus semi-intensive plantain cropping systems are an alternative and occur on more commercially oriented farms. Plantains also persist in older fields where cocoa tree density is reduced by mortality. Other traditional cropping systems combine plantain and yam, which are established following deforestation. This study describes the structure and functioning of current cropping systems in south-western Cameroon. New cropping systems based on plantain could be developed that reconcile commercial production and durability. Indigenous innovations already used by some farmers could provide alternative answers for progressive intensification, but agronomical performance and ecological sustainability remain to be evaluated before promoting them.

1340-1440

S10-P-10

WESTERN FLOWER THRIPS DIFFERENTIALLY ATTRACTED TO FOUR *VERBENA* CULTIVARS

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Western flower thrips (WFT) impacts floriculture crops worldwide through feeding and by vectoring plant viruses. They have acquired resistance to many insecticides used in greenhouses. Currently insecticide choices are limited due to federal regulations. As a result, a holistic pest management approach that favors a reduction in the number of insecticide applications is essential. Integrated pest management (IPM) programs are being developed to deal with WFT. However, the use of trap crops, which has been successfully incorporated into agronomic cropping systems, has not been utilized in greenhouses. Trap crops function by using a pest's preference for a certain plant species, cultivar, or crop stage, to prevent pests from concentrating on the main crop or to attract pests to a certain area where they can be locally controlled. Pesticide application cost reduction and increased yields result in net economic gains when trap crops are used. Trap crops may also serve as reservoirs for natural enemies of pests thereby enhancing biological control effectiveness. Antidotal evidence supports WFT preferences for some verbena cultivars over others; however, WFT crop preferences must be determined in a controlled experiment before trap crops become a viable option in IPM programs. Using a split plot design, 4 verbena cultivars from the Tapien series were placed in 10 greenhouses. Each greenhouse was divided into quadrants with one 15 cm pot of verbena randomly assigned to each quadrant. Endemic WFT populations were determined by yellow sticky card captures at a central location in each greenhouse. Yellow sticky cards were placed immediately above verbena cultivars and the weekly number of WFT captured was determined for a 6-week period. Population levels varied among greenhouses. When placed among various crops, the verbena cultivar 'Lavender' from the Tapien series attracted more WFT than 3 other verbena cultivars or the control. This cultivar may be a useful trap crop.

1340-1440

S10-P-11

THE AGROCLIMATE APPLICATION INFORMATION SYSTEM FOR CROP PRODUCTION AND PROTECTION IN EGYPT

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Uniformity of irrigation water and fertilizers, pests and diseases prediction and planting dates of the major crops are critical problems under different climatic regions in Egypt. The old land is characterized by uneven field surface, short furrows and small basin, deep percolation, water and fertilizer losses, soil profile heterogeneity, and other soil characteristics that all affect water and fertilizers distribution. Early planting is one of the options for summer cultivated crops in order to get the maximum yield at harvesting. Early good predic-

tion for diseases and insects to help the farmers avoiding the heavy spray of pesticides and take necessary actions to avoid dangerous diseases. In each cases yield reduction is the final result. Proper management nowadays depend on accurate irrigation scheduling—that reduces the cost of irrigation and minimizes problems related to the misuse of water—and early pest and disease forecast and warnings—this allows suitable time for taking necessary actions to avoid chemical spray. Proper calculation of sowing dates ensures uniform plantations and reduces the cost of sowing several seeds in many crops. The above mentioned agromanagement practices in addition to irrigation scheduling requires real time weather data system covering the country. The Central Laboratory for Agricultural Climate (CLAC) has established a system that covers more than 30 agrometeorological stations. Dissemination of information is another effort that CLAC is taking care of through different mass media facilities. Computer modeling is used to predict and calculate water and fertilizer use efficiency, diseases and insects' prediction and planting dates, as well as application efficiencies in different climatic regions. Diseases and insects prediction is determined according to the agroclimatological data especially air temperature and soil moisture. The proper diseases prediction is conducted by built-in software under prevailing climatic conditions in Egypt. Growing degree units (GDU) is used for the prediction of diseases and insects predictions. GDU is calculated simultaneously as new weather data is received from the weather stations. Planting dates for vegetable crops are also determined according to the agroclimatological data especially soil temperature. It is not well known the precise soil temperature for each cultivar of different vegetable species. This is especially important for selecting the proper cultivation time and area in order to achieve the best germination and escape the major diseases and pests.

1340-1440

S10-P-12

REDUCED TILLAGE PRODUCTION SYSTEM ALTERNATIVES FOR PROCESSING TOMATOES AND COTTON IN CALIFORNIA'S SAN JOAQUIN VALLEY

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Less than 1% of row crop acreage in California is currently farmed using conservation tillage (CT) practices. Adoption of CT systems in California has, however, increasingly been seen as a potential means for improving profitability, reducing energy use, and sustaining resources. Several studies are currently underway throughout the State to explore cropping system options for reducing tillage. In the fall of 1999, we established a 3.2 hectare field experiment comparing conservation and standard tillage (ST) cotton and tomato production systems with and without winter cover crops at the UC West Side Research and Extension Center in Five Points, CA. To date, we have demonstrated that planting and harvesting crops with CT systems is possible given some equipment modifications and that yields can be maintained relatively close to those of standard tillage in CT crop residue environments. Data from the second year of this study indicate that tomato yields in the CT + cover crop systems were similar to those in the ST plots, with an elimination of six tillage operations following last year's cotton crop in the CT plots relative to the standard till systems. 2001 cotton yields were reduced 11% and 18% in the CT – cover crop and CT + cover crop systems, respectively, relative to the ST control system, however, there was an elimination of 8 or 9 tillage operations in the CT systems relative to the ST approach following the 2000 tomato crop. Estimated resource use per acre (hours of labor and gallons of fuel) indicate the possibility of the CT systems to reduce these inputs relative to the standard till systems. This study is the first of its kind in California to systematically compare tillage system alternatives through a crop rotation. Longer-term implications of these reduced till regimes in terms of soil compaction, water use, profitability, soil carbon sequestration, insects and diseases are being evaluated as the study progresses through a 4-year cycle.

1440-1500

S10-O-13

EVALUATION, DESIGN, AND CONTROL OF SUSTAINABLE HORTICULTURAL CROPPING SYSTEMS

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As all other human activities, horticulture is accountable for its impact on the resources available, now and in the future, to our societies. The problem is of particular importance in production systems that are often intensive and require high amounts of inputs. To fit with the growing number of regulations and contracts growers have to respect, tools must be designed to evaluate existing cropping systems and design original ones with respect to sustainability. Evaluation is possible either beforehand or during the implementation of the sequence and spatial combination of crops and corresponding technical operations that constitute a cropping system. For example, the irrigation and fertilisation of lettuce crops can have strong consequences on the outflow of nitrogen to the water table and on the quality of products. Prototypes of management strategies can be evaluated with a model of the soil-crop system (de Tourdonnet 1999). Evaluating and/or designing a strategy should be based on the modeling of not only the biophysical system (the crop and its environment) but also the decision system. For example, the CONCERTO model (Rellier et al., 1998) simulates the management strategy, the labour organisation and the interactions between these components and a greenhouse-tomato crop system. In this framework, indicators are needed for the implementation of a strategy. They may be quantitative or qualitative but they should be relevant as well as easy to use by growers. One of the way of formalising a management strategy is provided by artificial intelligence. For example, in the SERRISTE expert system (Tchamitchian 1997), the knowledge basis was built from decision rules about greenhouse climate control provided by human experts. Such examples show that models and DSS are relevant tools to assess the adequation of horticultural cropping systems to the new standards of resource management.

1500-1520

S10-O-14

ANALYSIS AND DESIGN OF A LEEK-CELERY INTERCROPPING SYSTEM USING MECHANISTIC AND DESCRIPTIVE MODELS

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Intercropping leek and celery was recognized as an option to reduce growth and reproductive potential of weeds while maintaining yield and product quality of both crops on a high level. To optimise the intercropping system for yield, quality and weed suppression a combined use of mechanistic and descriptive models, together with experimental work, was applied. An ecophysiological model was used to improve understanding of interplant competition based on physiological, morphological and phenological processes. The model was parameterised based on characteristics of the plants in monocultures and its performance was evaluated for the crop mixtures using experimental data from different growing seasons. After validation the model was used to simulate biomass production and quality of leek, celery and seed production of the weed *Senecio vulgaris* for a wide range of crop densities and times of weed emergence. In a second step, the results of the simulations were summarized using a descriptive hyperbolic yield-density model, which then allowed evaluation of the intercropping system in terms of productivity, product quality, and the ability to suppress weeds. The paper will explain this combined modelling approach and how it was used to design and optimise the leek-celery intercropping system. Moreover, this study shows that functional biodiversity, as represented by the intercropping system, can contribute to the improvement of the economical potential while increasing the sustainability of highly developed agricultural production systems.

1520-1540

S10-O-15

RESEARCH ON BIOMASS DEVELOPMENT AND RESIDUE DECOMPOSITION OF HORTICULTURAL CROPS FOR EROSION PREDICTION MODELS: PHILOSOPHY AND METHODOLOGY OF DATA COLLECTION

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The increased demand for food and fiber, due to population increase, is causing marked acceleration of soil erosion. The Universal Soil Loss Equation (USLE) and its replacement, the Revised Universal Soil Loss Equation (RUSLE), are the most widely used of all soil erosion prediction models. Of the five factors in RUSLE, the cover and management (C) factor is the most important one from the standpoint of conservation planning because land use changes meant to reduce erosion are represented here. Even though the RUSLE is based on the USLE, this modern erosion prediction model is highly improved and updated. Alcorn State Univ. entered into a cooperative agreement with the NRCS of USDA in 1988 to conduct C-factor research on vegetable and fruit crops. The main objective of this research is to collect plant growth and residue data that are used to populate databases needed to develop C-factors in RUSLE, and used in databases for other erosion prediction and natural resource models. The enormous data collected on leaf area index (LAI), canopy cover, lower and upper biomass, rate of residue decomposition, C:N ratio of samples of residues and destructive harvest and other growth parameters of canopy and rhizosphere made the project the largest data bank on horticultural crops. Philosophy and methodology of data collection will be presented.

1540-1600

S10-O-16

ENVIRONMENTAL SYSTEM ANALYSIS FOR HORTICULTURAL CROP PRODUCTION

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In this paper an environmental system analysis for horticultural production processes of different intensity (outdoor cropping, protected cultivation in a greenhouse) is presented. One of the first steps in such a system analysis is the inventory analysis for the different production steps. This permits a weak point analysis of the whole production process and gives for example information about the most energy consuming production steps. In the presented outdoor cropping system a great part of the environmental impacts are related to transport processes. Therefore, there is a great potential for increasing efficiency by optimising the transport system. In the greenhouse production system a big part of the environmental impacts is related to the greenhouse material itself and the heating process. In this system a high potential for increasing efficiency lies in increased productivity and optimised cultivation strategies. The investigations demonstrate, that there are also different potentials for increasing the energy efficiency of the present system: reducing the inputs and unnecessary outputs with technology already available; reducing the inputs and unnecessary outputs with new technology (e.g., closed systems, precision horticulture); intensifying the production (increasing yield per unit input or redundant output). The results from such a system analysis of the whole production process help the growers to improve the efficiency of their operations. The input costs of the production process (labour, machinery, land, water, fertilisers pesticides and energy) are a significant portion of the overall farm operation costs. Thus a more efficient use of environmentally sensitive inputs can reduce both, the production costs for the farmer as well as the environmental risks or impacts.

1600-1620

S10-O-17

SUSTAINABLE VEGETABLE PRODUCTION: EFFECTS OF CROPPING SYSTEMS ON WEED AND INSECT POPULATION DYNAMICS

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Sustainable agriculture continues to attract the attention of policy makers, researchers, and growers. While a lot of research and extension activities have been devoted to sustainable production systems in agronomic crops, there have been few studies on vegetables. This study was conducted in 1999 and 2000 in California to evaluate the effect of cover crops and management systems on weed and insect populations in lettuce. Cover crops treatments included cowpea (*Vigna unguiculata*), sudangrass (*Sorghum bicolor*), and the traditional summer dry fallow. Management systems included Conventional (CON), Integrated (ICM), and Organic (ORG) systems. Cover crops were grown in the summer, followed by fall lettuce. Over the two years, cover crops had no effect on insect populations in

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lettuce, as neither cover crop is an alternate hosts for lettuce insect pests. However, the population of cabbage loopers [*Trichoplusia ni* (Hubner)] increased at the end of each growing season in cowpea mulch plots. The increase in loopers was greater in 2000 than in 1999. Cowpea cover crop suppressed weeds and increased yield. Lettuce yield was reduced when sudangrass was the previous crop. Lettuce leaf tissue and soil analyses strongly suggest a possible allelopathic interaction between sudangrass residues and lettuce. The ICM system reduced production inputs. For example, the number of insecticide applications was reduced from four to one without an increase in insect damage. After 2 years, the ORG system produced lettuce yield equivalent to that obtained in the CON system and resulted in more weed suppression than the CON system. Cowpea cover crop offers many advantages in vegetable based cropping systems. Cowpea and sudangrass are compatible with CON, ICM, and ORG management systems. Studies need to be conducted on the effect of sudangrass on rotational crops. The biological mechanisms behind improved weed suppression in organic plots also needs to be elucidated.

1620-1640

S10-0-17-A

TO BE ANNOUNCED

1640-1700

S10-0-17-B

TO BE ANNOUNCED

Tuesday · August 13

1100-1120

S10-0-18

WOOD CHIPPING ALMOND BRUSH AND ITS EFFECT ON THE ALMOND RHIZOSPHERE AND SOIL NUTRIENT STATUS

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The wood chipping of almond prunings, instead of burning, as a method to reduce air pollution and return organic matter to soils, could become an important orchard practice for almond growers in the San Joaquin Valley of CA. Wood chipping could provide an alternative to burning which would not contribute to pollution while adding valuable organic matter to soils. The success of wood chipping depends on whether the chips decompose quickly and are not harvested with nuts, and that critical nutrient necessary for tree growth are not depleted. An experiment was established where wood chips were mixed with soil and placed in containers, each with an almond tree, in order to quantitatively examine the effect of wood chips on soilborne organisms living within rhizosphere and soil nutrient status. Tissue analysis was performed on leaf petioles to determine whether the wood chips had an effect on nutrient availability. After the first year, trees growing with wood chips had significantly less nitrogen, zinc, and manganese while phosphorus was increased. After the second year, trees with wood chips no longer had significantly less nutrient levels while phosphorus levels were still significantly increased. Soil analysis after the second year showed significantly higher levels of zinc, copper, organic matter, phosphorus, potassium, ammonium, calcium, and magnesium. The pH in the chipped soils were significantly decreased while the electrical conductivity was significantly increased. When nematode populations were analyzed there were significantly less ring (*Criconeimella* sp.) and stubby root nematodes (*Trichodorus* sp.) and significantly more *Bunonema*, *Doryleimida*, and free living nematodes in the chipped soils. Of the free living nematodes, there was a higher percentage of fungal feeders in the chipped soils while the non-chipped soils had a higher percentage of bacterial feeding nematodes.

1120-1140

S10-0-19

DEGRADABLE MULCH AS AN ALTERNATIVE FOR WEED CONTROL IN LETTUCE PRODUCED ON ORGANIC SOILS

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Lettuce in Quebec is primarily grown on organic soils where weed control accounts for 30% of the preharvest production cost. As no efficient post emergence herbicide is available, weeding is done mechanically and manually. Using a mulch could be a possible alternative to current practises. Degradable paper mulches (pale, pale/black, black/pale) were compared with polyethylene mulches (black, white/black) and a manually weeded nonmulched control. The experiment designed as a randomized completed block with 4 replications was carried out in 1999 and 2000. Polyethylene or paper mulches with at least one black side were effective in controlling weed growth in both seasons. In 1999, air and soil temperature of paper mulch plots were similar to the control. Day temperatures for the white/black polyethylene mulch were reduced by 2.8 °C for air and 1 °C for soil compared with the control. Soil humidity was highest under the polyethylene followed by the paper and finally the nonmulched control. Lettuce grown on paper or polyethylene mulches had 25% more marketable yield, and were significantly heavier than nonmulched lettuce. In 2000, air temperatures of all mulches were similar to and 1 °C above those of the control. When the black side of mulches were exposed to the sun, the soil temperature increased by 2.8 °C compared with treatments where the pale side of the mulch was exposed. Lettuce grown in treatments with higher soil temperatures had longer stems. Soil moisture was similar in mulched and nonmulched plots. Growing lettuce on paper or polyethylene mulches increased marketable yield by 7% and resulted in significantly heavier heads compared with the control. Although similar yields were obtained with both paper and polyethylene mulches, the former has the environmental and practical advantage being able to degrade in the soil at the end of the season.

1140-1200

S10-0-20

ENHANCED PEST MANAGEMENT WITH COVER CROP MULCHES

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Living and dead plant vegetation on the surface of soils can provide opportunities for regulating pest populations in no-tillage production systems. Cover crops generate substantial quantities of surface vegetation and residue that can be managed to enhance control of specific pests. Research at the Beltsville Agricultural Research Center has shown that weed germination and emergence is inhibited by high levels of cover crop mulch, that small-seeded annual weeds are particularly susceptible to suppression by mulches, and that herbicide use can be reduced when cover crops are incorporated into cropping systems. Growing mixtures of legume and cereal cover crops is a particularly effective way to produce large quantities of cover crop residue for weed suppression. Mulches with a high surface area to soil area ratio and a low amount of internal empty space are most highly correlated with inhibition of weed emergence. Foliar diseases also can be reduced by cover crop mulch, primarily by preventing dispersal of pathogen propagules through splashing and/or windborne processes. Insect pest management can be achieved either through reduction of populations emerging from soil or by enhancing populations of predatory insects. In addition to direct effects of cover crops on pest populations, improvements in soil organic matter and fertility by cover crops can reduce pest damage by improving the growth and vigor of crop plants.

1200-1220

S10-0-21

SUSTAINABLE PRODUCTION SYSTEMS FOR TOMATO IN SOUTH FLORIDA

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Florida ranks first in fresh market tomato production in the U.S. A successful tomato production in Florida depends on use of fertilizers, polyethylene plastic cover and methyl bromide. These cultural practices are costly and can

be environmentally hazardous, to include leaching of excess fertilizers, disposing of plastic mulch through incineration and adverse impact of soil fumigants on beneficial microorganisms and on ozone layer. Hence, developing alternative cropping systems is needed in Florida to ensure continuity of fresh market tomato production under economically and environmentally sustainable conditions. From 1998 to 2001 cover crops, herbicides and nematode resistant tomato varieties were evaluated on gravelly calcareous soil of south Florida for sustainable tomato production. Several cover crops were screened for total biomass, resistance to root-knot nematode and weed suppression in the first of the study. Sunn hemp, sorghum Sudan, millet, and cowpea were selected for a second year. Tomato yields were low in all treatments except in sunn hemp and methyl bromide treatments. Sunn hemp was the highest biomass yielder among the cover crops, had highest nitrogen content, higher resistance to nematodes and suppressed weeds for longer period than other cover crops. In the third year we evaluated sunn hemp with and without plastic, additional fertilizer, and herbicides. Results showed that using sunn hemp as a cover crop provided a high biomass (14.7 Mg/ha), was very effective when used with supplemental fertilizer for tomato production on plastic mulch. Tomato yields were high (45.12 MT/ha) compared to those in sunn hemp without fertilizer and plastic treatment (30.61 MT/ha). Root-knot nematode galling on tomato roots was very low in sunn hemp treatment without herbicides and was comparable to those in methyl bromide treatment. Weeds were suppressed under plastic during tomato production season. These sustainable production systems were effective for tomato production.

1220-1240

S10-0-22

NONCHEMICAL INSECT AND DISEASE MANAGEMENT IN CUCURBIT PRODUCTION SYSTEMS

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We conducted field experiments in 2000 and 2001 in California's San Joaquin Valley to evaluate the effectiveness of wheat straw mulches for insect and disease control in squash production. Experimental treatments included 1) untreated (no insecticide) control, 2) Admire insecticide treated, injected into the soil 1 day before planting 3) silver reflective plastic mulch, 4) chopped wheat residue from fall planted wheat as a surface mulch, and 5) hand-scattered wheat residue from baled straw. In general, squash silverleaf and virus symptoms tended to be lower over the silver reflective plastic, the scattered straw mulches and the Admire-treated plots than in either the harvested wheat residue or the control plots. Similarly, plants in these treatments produced both earlier and higher cumulative yields than plants growing over the planted wheat mulch or the untreated control. These preliminary findings indicate considerable promise of the alternative mulch systems for non-chemical management of late season insect and disease pests of this crop.

1340-1440

S10-P-23

DECREASE OF NITROGEN FERTILIZER APPLICATION IN TOMATO PRODUCTION IN NO-TILLED FIELD WITH HAIRY VETCH MULCH

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Growth and yield of tomatoes were estimated when they were planted in a no-tilled field with hairy vetch (*Vicia villosa*) mulch (NT+HV), added with 80, 160 and 240 kg/ha of nitrogen fertilizer, and compared to tomatoes grown in a tilled field with black polyethylene film mulch (Till+BP). Seed of hairy vetch (50 kg/ha) was sown in the Field Center of Niigata Univ. on October 21, 1999, and hairy vetch (3200 kg/ha dry weight) was mowed on May 17, 2000, to make organic mulch. Twenty percent of nitrogen was applied by fast-effect fertilizer and the rest (80%) by slow-effect fertilizer. Tomato cv. Momotaro was planted in NT+HV and Till+BP on May 19, 2000, and grown until early in September. The nitrate concentration in the petiole of the leaves near 2-3 cm width fruit decreased from 50 or 60 days after planting in the Till+BP. However, it maintained more than 2000 ppm until 70-80 days after planting in NT+HV. The growth index of tomatoes grown in NT+HV became higher after 50 days com-

pared with Till+BP in 80 kg/ha of nitrogen. The tomato yield in NT+HV was lower than that of Till+BP in the first and second fruit cluster, but was higher from third to 7th cluster in 80 kg/ha of nitrogen. No definite effect of nitrogen fertilizer in the yield was recognized among 80, 160 and 240 kg in NT+HV. The total marketable yield of NT+HV was higher than that of Till+BP in 80 kg/ha of nitrogen fertilizer. However, no difference was recognized between NT+HV and Till+BP in the application of 160 and 240 kg/ha of nitrogen fertilizer. By using no-till and hairy vetch mulch system, even if nitrogen fertilizer is decrease to the 80 kg/ha, recommended level in tomato production for environmental preservation, the marketable yield will be the same level obtained with 160 and 240 kg of nitrogen.

1340-1440

S10-P-24

WINTER LEGUME COVER CROPS ELIMINATE NEED FOR N FERTILIZERS FOR CANTALOUPE AND SWEET CORN PRODUCTION

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The use of inorganic fertilizers, especially N, has been an enigma for modern agriculture: on one hand, their use has been linked to environmental pollution, while on the other hand they have contributed to yield increases. Estimates of crop absorption of applied N range from 25% to 70% and unused nitrogen can increase salt content of the soil and production costs, and can lead to runoff and leaching, thus, contaminating surface and groundwater. In comparison with conventional, high-intensity agricultural methods, organic alternatives such as use of N fixation by legumes to support production of succeeding non-legume crops can improve soil fertility and have fewer detrimental effects on the environment. Studies were conducted during 1998-99, 1999-2000, and 2000-01 seasons to determine if winter legume (White Lupin, Hairy Vetch, and Austrian Winter Pea) as cover crops can be used to produce cantaloupe and sweet corn, without application of N fertilizer. We compared yields of cantaloupe and sweet corn when grown following three legumes (Lupin, Hairy Vetch, and Austrian Winter Pea) used as cover crops, 110 kg/ha of N, and a control treatment that did not receive any fertilizer. This study indicated that use of either lupin or hairy vetch as a winter cover crop for production of cantaloupe and use of lupin as cover crop for production of sweet corn results in their performance being better than if 100 kg/ha of N fertilizer were used.

1340-1440

S10-P-25

EFFECT OF NO-TILLAGE AND RYE MULCH ON OCCURRENCE OF WEEDS AND APHIDS AND ON YIELD OF CABBAGE, CARROT AND RED BEET

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In 1999 cucumber, lettuce and snap bean were grown on experimental field for the first time using no-tillage method and rye as cover crop and in the year 2000 cabbage, carrot and red beet were grown on the same field using the same cultivation method. Rye was sown in the middle of September and at the beginning of May it was desiccated with glyphosate. Two weeks later seeds of carrot (*Daucus carota* L.) cv. Nantejska and of red beet (*Beta vulgaris* L.) cv. Chrobry and transplants of cabbage (*Brassica oleracea* L. var. *capitata* L. f. *alba*) cv. Sawa z Enkhuizen were planted on no-tilled field covered with rye mulch and on field cultivated conventionally. Three weeks after planting the number and the fresh weight of weeds growing on no-tilled plots were reduced by 99% in comparison to conventional tillage. Four weeks later the differences in weed infestation between compared treatments were considerably smaller but still significant. However, the number of *Taraxacum officinale* plants growing on no-tilled plots was bigger than on plots cultivated conventionally. At the beginning of July about 10% of carrot plants cultivated conventionally and 5% under no-tillage cultivation were invaded by *Semiaphis dauci* F. Similar cabbage plants were less invaded by *Brevicoryne brassicae* L. on no-tilled than on conventionally tilled plots. No aphids were found on red beet plants. Method of cultivation did not influence significantly total and marketable yield of vegetables, however on no-tilled plots cabbage grew slower and therefore it was harvested three weeks later.

1340-1440

S10-P-26

COVER CROPS FOR VEGETABLE PRODUCTION SYSTEMS IN KANSAS

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Productivity of twelve spring-, summer-, and fall-planted cover crops was assessed in parallel trials over two seasons on a Kennebec Clay Loam soil at Olathe, Kansas. Effects of cover crop species, tillage dates (early and late), and manure application (well-rotted cow manure at 4.5 t/ha) prior to tillage, on soil nitrogen levels were also determined in these trials. Suitability of the cover crops for vegetable production was further assessed by a follow-up crop of spinach or swiss chard. A strip plot design with 4 replications was used for the trials, with cover crops or uncropped controls as main plots, and tillage dates (late and early) and manure applications as subplots. Cover crops and crop combinations assessed were as follows: berseem clover, Canadian field peas, forage rape, and purple vetch/rye (spring-planted); buckwheat, cowpea, sorghum-sudangrass, and soybean (summer-planted); and annual rye grass, Austrian winter pea/oat, hairy vetch/rye, and sweetclover (fall-planted). Spring-planted cover crops were sown in April, and incorporated in June (early) and July (late). Summer-planted cover crops were sown in June, and incorporated in the fall or the following spring. Fall-planted cover crops were sown in September and incorporated in June or July. The purpose of manure application was to assess whether it would serve as an inoculum to hasten breakdown of cover crop residues on newly cover-cropped land. Soil nitrogen (ammonia and nitrate) levels were measured two days and two weeks following tillage. There were significant differences among cover crops with respect to productivity and nitrogen release following tillage for each group of cover crops. Forage rape was the most productive spring-planted cover crop, and resulted in an elevated soil ammonium levels. Sorghum-sudangrass significantly outyielded other summer-planted cover crops. Hairy vetch/rye was the most productive fall-planted cover crop combination.

1340-1440

S10-P-27

EFFECTS OF COVER CROPS, COMPOST AND MANURE AMENDMENTS ON YIELD OF FRESH-MARKET TOMATO

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Alternative tomato (*Lycopersicon esculentum* Mill.) production systems that improve soil structure and reduce the use of synthetic N were investigated using poultry manure compost, poultry manure and hairy vetch (*Vicia villosa* Roth.) cover crop. A randomized block design experiment was used and consisted of seven treatments: hairy vetch mulch (HV), conventional plastic mulch (PM), three levels of poultry manure compost (5, 10, 20 ton/ha—low, medium and high) with PM, two levels of poultry manure (2.5, and 5 ton/ha low and high) with PM and a mixture of HV plus compost (10 ton/ha) was included in the last year. Rates of N mineralization from compost and manure were determined prior to field application, and adjusted optimum levels of N were attained by adding NH_4NO_3 at time intervals commensurate with plant growth. Tissue N analysis was performed during the growing season and showed adequate N levels in plant tissues. In the first year highest tomato yields were produced in soil amended with poultry manure at high level (52.2 ton marketable fruit/ha), hairy vetch at 8 t dry matter/ha (48.8 ton/ha), and soil amended with poultry compost at high level (48.3 t/ha). In the second year, highest yields were obtained in soil amended with the mixture of hairy vetch and poultry compost (57.8 ton/ha) and the poultry compost at high level (50.9 ton/ha). Fruit size was significantly smaller in the hairy vetch mulch and medium level poultry manure compost treatments than in all other treatments in the first year, but no significant difference in fruit size was found in the second year. The highest yields found in the mixture and the high level of poultry compost indicated that a combination of cover crops with compost or compost alone can improve tomato yields. These treatments also may be beneficial to soil quality and improvement of soil microbial communities.

1340-1440

S10-P-28

SHEEP MANURE IMPROVES THE NUTRIENT HOLDING ABILITY OF APPLE ORCHARD SOILS

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Two experiments were designed to test effects of sheep manure on nutrient holding ability of sandy apple orchard soils in Shandong, China. Experiment 1: 3-year-old 'Starkrimson' Red Delicious/*Malus hupehensis* apple trees were treated with different amounts of sheep manure (0–30 ton/hectare) for two years, and then soils in the root zone were sampled for measuring the cation exchange capacity (CEC). Experiment 2: the sandy soil from the same orchard was incubated with different amounts of sheep manure (0–30 ton/hectare) in 4-L pots mixed with 1 g N as in urea for 60 day under the room temperature (20–25 °C), and then the pots were rinsed with different amounts of water as artificial rains (0–10 mm rainfall equivalent) and available nutrients remained in soil were measured after the rinse. The results shown that sheep manure improved soil CEC, and CEC value positively related to the amounts of the manure applied into the soil. Soil available nutrients negatively related to the amounts of rinse water, but at each level of the 'rainfall', the available nutrients remained in the soil increased with the increase of sheep manure in the incubation mix. We concluded that sheep manure improved soil nutrient holding ability.

1340-1440

S10-P-29

DISTRIBUTION OF MYCLOBUTANIL FUNGICIDE SENSITIVITIES AMONG POPULATIONS OF *VENTURIA INAEQUALIS*, THE CAUSAL AGENT OF APPLE SCAB, IN ONTARIO

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Apple scab caused by *Venturia inaequalis* is considered to be the single most important disease of apples in several production areas. In recent years an increase of apple scab has been observed in orchards in Ontario. To determine if the increase in apple scab is due to fungicide resistance, sensitivity of six populations of *V. inaequalis*, collected from four geographical locations in Ontario, to myclobutanil was tested. Sensitivities of isolates to fungicide were determined by a sensitivity test based on the relative growth (RG) of mycelial colonies. Mean isolate sensitivities were not significantly different for the majority of the populations tested. Similar fungicide sensitivities were observed between a wild-type population, that has never been exposed to DMI, and populations sampled from orchards that were never or rarely treated with myclobutanil. Isolates from myclobutanil treated apple orchards showed some tolerance to the fungicide, however, the populations did not reach the practical (field) resistance levels. The presence of fungicide tolerance will have a significant implications with respect to programs managing apple scab and myclobutanil resistance.

1340-1440

S10-P-30

EVALUATION OF LIMITED TILLAGE, ROTATION AND COVER CROP SYSTEMS TO REDUCE N USE AND SOIL EROSION FOR SMALL ACREAGE VEGETABLE FARMS MIRROR IMAGE PROJECT IN URUGUAY AND NORTH CAROLINA, USA

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Nitrogen management is a primary determinant of vegetable crops production in the U.S. and in Uruguay. We evaluated 7 rotational systems for vegetable crops in both countries. These rotational systems influence N fate in the

environment in different ways and impact both cost of production and the environment. We used rotational systems that include both winter and summer cover crops and vegetable crops. Insects, diseases and weed infestations differed with the systems. All activities were closely coordinated via e-mail and annual visits to ensure an integrated approach to crop and pest management. Crop growth, yield, quality, nutrient cycling and soil microbial activity measured. Nitrogen status of cover crops, cash crop and soil were determined at 6 depths to establish an N balance for each system. Market price data are being combined with normalized treatment data to determine gross revenues, operating costs, and net revenue per acre. Input and production data from all production systems is used to evaluate economic feasibility for both traditional and more sustainable vegetable production systems. In addition to production benefit/cost determination, we will determine environmental benefit/cost relationships as a result of the various production systems.

1340-1440

S10-P-31

COMPARISON OF ORGANIC AND INORGANIC MULCHES FOR HEIRLOOM TOMATO PRODUCTION

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Many tomato growers face challenges in producing their crops due to stricter environmental regulations and fewer chemicals available for weed control. There is a demand for cultural practices that reduce chemical inputs and synthetic materials. Heirloom tomato varieties, once traditionally grown in backyard gardens, are becoming more popular among commercial tomato growers due to increased demand from consumers. Since most heirloom tomatoes at present are grown on small acreage, the addition of organic mulches may be a practice feasible for growers. Heirloom tomatoes were grown in 2000 and 2001 using organic mulches (shredded newspaper, wheat straw and composted landscape bark) and an inorganic mulch (black plastic) plus a bare ground control to evaluate their effectiveness on heirloom tomato marketable yield, weed density and biomass, soil temperatures, and decomposition rate of organic mulches. All treatments were grown with preemergence herbicide (high input) and without preemergence herbicide (low input). In 2000, marketable yields for the 10 treatments ranged from 3.4 to 50 MT/ha. Highest marketable yields were achieved with shredded newspaper mulch, regardless of herbicide input. Mulch x herbicide interactions were not significant for yield. Bare ground control with no herbicide inputs resulted in the lowest yields and highest weed densities and biomass. Among the organic mulches, although newspaper generally produced the lowest soil temperatures, it produced the highest yields and most complete weed suppression. This may be due to the fact that newspaper had the lowest decomposition rate and may have formed a better barrier against weed emergence. Black plastic produced the highest soil temperatures, but produced the lower yields than the organic mulch treatments for low and high input levels. Results from the 2001 growing season are presently being analyzed. Results from both years of this study will be presented.

1340-1440

S10-P-32

BIOLOGICAL CONTROL FOR THE MANAGEMENT OF HORTICULTURAL CROP PESTS: COLONIZATION OF *COTESIA FLAVIPES* CAMERON (HYM.: BRACHONIDAE) AGAINST *CHILO PARTELLUS* SWINHOE (LEP.: CRAMBIDAE) IN ZANZIBAR ISLANDS

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Cotesia flavipes, a biological control agent of the stemborer *Chilo partellus* was released in cocoon stage on Unguja and Pemba islands of Zanzibar in May

2000. Two hundred and fifty cocoons were released once in each of 16 sites selected on Unguja and 12 sites on Pemba. To determine its colonization, maize plants with stemborer symptoms were randomly sampled in the field, excised and dissected to remove larvae and pupae. *Cotesia flavipes* was first recovered two weeks after release and was the most predominant parasitoid throughout the season. It parasitized all the three stemborer species present in these sites. However it was recovered in significant numbers from the target pest *C. partellus*. Recoveries were made in 25 of 28 sites, indicating that colonization of stemborers by *C. flavipes* occurred in these areas. It was responsible for 6.3% and 16.1% of larval parasitism on Unguja and Pemba, respectively. Parasitism by indigenous parasitoids was too low to suppress the pest population below economic damage levels. *Cotesia flavipes* was recovered in at least 8 sites one year after release, confirming that it has firmly established on the islands. A monitoring programme to determine its dispersal and spread on the islands is now recommended.

1340-1440

S10-P-33

LONG TERM LARGE SCALE SOIL SOLARIZATION AS A LOW-INPUT PRODUCTION SYSTEM FOR FLORIDA VEGETABLES

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Intensive vegetable production systems utilizing methyl bromide/chloropicrin fumigation with raised beds, polyethylene mulch, and high fertilization levels have resulted in high vegetable crop yields in many areas, including south Florida. Alternatives such as solarization and organic amendments have given favorable results in theory and in small trials, but are largely unproven in large-scale use. The objective of this research was to determine the effects of soil solarization and organic amendments on farm-size plots of peppers (*Capicum annum* L.) and cucumbers (*Cucumis sativus* L.) over a period of 2 crop-years. The experiment was conducted during the 1998-99 and 1999-2000 growing seasons on a conventional vegetable farm in Boynton Beach, Fla. Four 1.3-ha plots consisting of 10 beds, 610 m long, all received preplant fertilization of 354N-39P-314K kg-ha⁻¹. Treatments were SC3: 3 years of soil solarization with compost; SC2: 2 years of soil solarization with compost; SF2: 2 years of soil solarization without compost; FF: continuous methyl bromide/chloropicrin with the same fertilization. Soil organic matter, pH, and Mehlich 1-extractable P, K, Ca, Mg, and Zn were higher in systems with compost than without. Manganese concentrations were not affected by treatments and Cu and Fe varied by year. Populations of the root-knot nematode (*Meloidogyne incognita*) fluctuated throughout the experiment. In 1999-2000, root knot nematode populations were lowest in the conventional system. However, at each sampling date, populations of at least one of the alternative systems were equal to that of FF. Marketable yields of peppers appeared to be similar within the production systems for the 1998-99 season. In general, results with conventional treatments with methyl bromide fumigation were more consistent; yields and other characteristics of the systems with soil solarization and compost are often similar and may be viable alternatives for some growers.

1340-1440

S10-P-34

DIFFERENT MULCHING METHODS FOR WEED CONTROL IN ORGANIC GREEN BEAN AND TOMATO

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A detailed experiment was conducted to determine the effects of eight methods of mulching on growth of the weed flora and crop plants such as green bean and tomato. We have used weedy, hoed and herbicide treated plots as control. Mulching methods were plastic sheet, paper mulch, straw mulch with and without Phylazonit-M microbial soil conditioner, grass clippings, leguminous clippings, compost and weed clippings. Weed coverage and crops' yields were determined. According to our results the weed suppress effect of plastic

sheet, paper and straw mulching have reached the values we have got at the herbicide treated plots, or it was overcome several occasions. Results of this experiment show that there are high possibilities for establishing a mulching system that is suitable to suppress the weed, to preserve soil structure and moisture content, and stimulate the soil biological activity.

1340-1440

S10-P-35

TARGETING MICROBIAL FOOD SAFETY TRAINING FOR SMALL SCALE GROWERS BASED UPON CURRENT KNOWLEDGE AND MANAGEMENT

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Recent outbreaks of foodborne illness associated with produce have prompted international attention on grower practices and produce handling. Most research and education efforts have focused on the needs of larger wholesale type farm operations. We investigated if current management for food safety varied among different farm sizes and organic certification. We surveyed of New York produce growers to compare organic amendment, irrigation water and post harvest management with U.S. federal guidelines to reduce food safety risk. The respondents (213 total) represented 36% of the produce acreage in the state and many (54%) farmed less than 100 acres (40 ha). Of the 76 respondents (36% of total) who applied manure or compost, most (88%) used practices that would reduce food safety risks based upon federal guidelines, but only 52% of growers knew these practices reduced risk. Most growers used surface water for irrigation (76%), but few reported testing water quality. Growers commonly washed produce on farm (92%) but rarely added sanitizers to this water (16%). General food safety training should increase emphasis on past outbreaks associated with produce and record keeping of manure and water management for traceback purposes. The survey results indicated that small farms specifically required additional training in three key areas: record keeping of manure applications, composting processes to achieve pathogen kill, and sanitation of wash water. Organically certified farms were more frequently in compliance with federal food safety guidelines for manure and water quality management than conventional growers ($P < 0.05$), but required additional training in proper composting to kill pathogens. These results have been incorporated into design of self-assessment tools for small farms, development of bilingual food safety educational materials, and design of food safety presentations and resources for training programs both in the U.S and internationally.

1340-1440

S10-P-36

BREEDING RYE (*SECALE CEREALE* L.) FOR USE AS A COVER CROP IN NO-TILL VEGETABLE PRODUCTION

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Rye mulches have a well documented allelopathic effect on weeds. Unfortunately, that effect has proven highly variable, resulting in poor weed control some years. Bioassay tests of rye tissues were conducted over the course of a growing season. The tests revealed a pattern of decreasing allelopathy as the plant matures. The rate of decline, however, is not the same for all varieties. Information obtained from this experiment is being used in a unique breeding program at North Carolina State Univ.. The goal of the program is to breed a highly allelopathic rye for use as a cover crop in no-till systems. To create an allelopathic mulch, the rye has to both produce the allelochemicals and retain them until planting time for the following crop. Increasing the retention may be possible by delaying the maturation of rye through breeding for a late flowering date. To start the breeding program, 278 accessions of rye were screened for allelopathy and flowering date. Fifteen of the most allelopathic accessions were chosen for inclusion in the breeding population. Only three flowered late, but the high heritability of this trait should allow for rapid movement of the population to a late flowering date. Release of the first cultivar will occur in 2-3 years.

1340-1440

S10-P-37

USING SOLARIZATION TO MANAGE WEEDS IN WARM CLIMATE VEGETABLE CROPPING SYSTEMS

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Soil solarization has been tested as a possible substitute for methyl bromide fumigation. In several experiments in two areas of the southern United States, we observed the effects of solarization on weed populations. Clear polyethylene over raised beds (15-18 cm high) was used in all experiments, and moisture was provided during solarization by drip irrigation or subsurface seep irrigation. In a sandy soil in southeast Florida, 1.2 ha blocks were solarized for 10 weeks. Control blocks were fumigated with 98% methyl bromide: 2% chloropicrin at 202 kg-ha⁻¹. During growth of a pepper (*Capsicum annuum* L.) crop, mean percent weed cover in solarized blocks (59.5%) was higher than the 14.8% in controls. In a sandy loam soil in the more arid climate of central Texas, beds were solarized from 22 July to 19 Aug., 1998. Broccoli (*Brassica oleracea* var. *botrytis* L.) was planted into plots. Mean dry weight of weeds collected from solarized plots 6 weeks after solarization (2.8 g) was lower than that from non-solarized plots (9.5 g). On 14 July, 1999, during growth of a subsequent tomato (*Lycopersicon esculentum* L.) crop, weed coverage in solarized plots (7.8%) was still lower than that from non-solarized plots (34.9%). On an organic farm in the same area of Texas, plots were solarized from 13 July through 26 Aug., before transplanting broccoli into plots. Although weed dry weights from non-solarized plots 6 weeks later were 2.2 times those from solarized plots, differences were not significant. In these experiments, solarization often lowered weed populations, even a year after solarization. Solarization can be an important weed management tool for warm-climate vegetable growers who cannot or choose not to use fumigation or other chemical weed control methods.

1340-1440

S10-P-38

NO-TILL VEGETABLE PRODUCTION USING ORGANIC MULCHES IN THE DRY TROPICS OF AUSTRALIA

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Conventional tillage practices and the use of plastic mulch in the dry tropical regions of Australia has led to the loss of soil organic matter and increasing problems of erosion, water logging and soil compaction. A no-till system using permanent beds, permanent subsurface irrigation and organic mulches grown in-situ, based on that developed by Abdul-Baki & Teasdale (1993) has been implemented as an alternative to conventional production. The system uses a tropical legume, *Centrosema pubescens* cv. Cavalcade, or tropical C₄ grass varieties Indian Bluegrass (*Bothriochloa pertusa*) cv. Keppel and cv. Hatch as cover crops over summer and fall. Which are then killed using herbicides and the residues left on the bed surface. Vegetable seedlings are then planted through the mulch residues and grown using conventional agronomy. Following harvest, crop residues are broken up and the next cover crop direct seeded through the mulch residues. The development and implementation of this no-till system of vegetable production has resulted in significant improvements in soil aggregate stability, soil bulk density and soil biological activity, whilst maintaining commercial productivity. Other benefits include the replacement of plastic mulch, a reduction in machinery running time, and continuous cover of the soil surface reducing the risk of erosion from major rainfall events. The system has the potential to be implemented in a range of vegetable crops including *Capsicum*, zucchini, melons, pumpkins, and aubergines over a range of vegetable production areas within Australia.

1340-1440

S10-P-39

CONTROLLED MICROBIOTIC COMPOST AND REACTOR TREATED SWINE WASTE COMPOST AS POSSIBLE ALTERNATIVES TO METHYL BROMIDE IN A PLASTICULTURE SYSTEM

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In 1999 we initiated a study of the use of composts for vegetables plasticulture. We used a control and methyl bromide, Controlled Microbiotic Compost (CMC) at 330 and 660 m³/ha and Reactor Treated Compost (RTC) at 6 and 12 T/ha. The composted were incorporated to 5, 10, and 15 cm in each successive year. The compost and methyl bromide treatments were applied to the same plots each year, but the location of the crops was rotated. The control and methyl bromide had the poorest yield of cucumbers. Controlled Microbiotic Compost (CMC) and Reactor Treated Compost (RTC) increased marketable of cucumbers yield by 30%. Similarly CMC and RTC increased the marketable yield of tomatoes by 100% and 70% relative to the nontreated control and methyl bromide treated control. In 2000, yields of cucumbers and tomatoes were great with methyl bromide than either of the two composts or the nontreated control. In 2001 methyl bromide still increased yields, but some compost treatments were almost equivalent. The nutrient removal and 0 to 15 cm soil nutrient levels for these trials will be discussed.

1340-1440

S10-P-40

WEED CONTROL IN NO-TILLAGE ZUCCHINI SQUASH PRODUCTION

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The current hindrance to implementation of no-tillage squash production in southern Illinois is the lack of adequate weed control, as previous studies have shown similar yields when no-tillage and conventional-tillage production systems are compared. Weeds become the major problem in this type of production system, as tillage is often used in conventional production to reduce weed populations that preemergent herbicides fail to control. Under a no-tillage production system, growers complain that during harvest laborers cannot find fruit as easily on squash plants that are shaded by weeds compared to squash growing in a weed-free field, and this contributes to yield loss. So, weed control strategies need to be developed to overcome the problem of weed competition. Various species of *Amaranthus*, including redroot pigweed (RRPW) are problematic in no-tillage squash production in southern Illinois. A field study was conducted over two growing seasons (2000 and 2001) to evaluate various herbicides or herbicide combinations to control smooth crabgrass (SMCG) and RRPW in no-tillage 'Independence II' zucchini squash production. Treatments that adequately controlled weeds with little injury to squash included various rates of Command + Raptor and Command + Curbit.

1340-1440

S10-P-41

THE EFFECTS OF LIVING MULCHES ON YIELD OF LEEK, PLANT OVERWINTERING AND BIOLOGICAL VALUE OF THE CROP

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Living mulches grown together with field vegetables cause suppression of weed and pest populations, reduction of nutrients leaching and enrichment of the soil in organic matter. The aim of the present study was to evaluate the effects of living mulches on yield of leek, plant overwintering and composition of the crop. In field study leek cv. Arkansas was grown from seedlings planted on 10 June. Perennial ryegrass, white clover and hairy vetch used as the living mulches were sown between plant rows after 3, 5, 7, 9, or 11 weeks from the date of transplanting. Harvest of leek was conducted in half of October or in early April. In both terms samples of edible parts of leeks were collected for chemical analysis. Results of the experiment showed that during autumn harvest the first two sowings of living mulches considerably reduced the leek biomass and marketable yield. Sowings delayed to 7, 9, and 11 weeks after transplanting did not adversely affect the plant growth. White clover, and hairy vetch in treatments with first two sowings appeared to be preferable for overwintering of leek plants. Living mulches did not influence the contents of dry matter, vitamin C, total and reducing sugars in edible parts of leeks. Plants harvested in spring season contained lower amounts of dry matter and total sugars, while higher level of reducing sugars.

1340-1440

S10-P-42

MYCORRHIZAL FUNGI ENHANCE GROWTH AND NUTRIENT UPTAKE OF BUSH MORNING GLORY (*IPOMOEA CARNEA*) FERTILIZED WITH ORGANIC AND INORGANIC SOURCES.

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This study investigated the utilization of arbuscular mycorrhiza fungi (AMF) to enhance the efficiency of slow release organic and inorganic fertilizers during container production of bush morning glory (*Ipomoea carnea* subsp. *fastulosa*). Uniform rooted liners of *Ipomoea carnea* were planted into 2-gallon (9.6-L) pots containing a pasteurized soilless medium [3:1 (v/v) pine bark to sand]. The mycorrhizal treatments consisted of two commercial AMF inocula: Bioterra Plus and Mycorise Pro, and a noninoculated control [NonAMF]. Fertilizer treatments included an organic slow release fertilizer [SRF] (Nitrell; 5N-3P-4K) and an inorganic SRF (Osmocote; 18N-7P-10K). Nitrell was tested at three levels: 8.4 kg-m⁻³ (14 lb/yd³), 12 kg-m⁻³ (20 lb/yd³), and 16.8 kg-m⁻³ (28 lb/yd³), which were, respectively, 70%, 100% and 140% of the manufacturer's recommended rate. Osmocote was tested at two levels: 6 lb/yd³ (3.5 kg-m⁻³) and 12 lb/yd³ (7.0 kg-m⁻³) which were, respectively, 50% and 100% of the recommended rate. With organic and inorganic SRF, both mycorrhizal inocula significantly enhanced the marketability, growth index, root, leaf, shoot and total plant dry mass of bush morning glory. The greatest growth response occurred with the highest level of Osmocote colonized with Bioterra Plus. The mycorrhizal enhanced growth response was in part due to greater N, P, K, B, Fe, and Mn uptake. Organic and inorganic SRF regimes did not inhibit mycorrhizal development, which ranged from 12% to 27% colonization.

1340-1440

S10-P-43

HEAVY METALS NON-NUTRIENTS IN TOMATOES PLANTS CULTIVATED WITH COMPOSTING MADE WITH BIOSOLID AND SUGARCANE BAGASSE

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This work studied the heavy metals non-nutrients concentration (Cd, Cr, Ni, and Pb) in composting process and when applied this composts in the Red-yellow Latosol, as well as the concentration and uptake by tomato plant. For this, was created composts using sugarcane bagasse, biosolid and cattle manure in these proportions: 75-0-25; 75-12,5-12,5; 75-25-0; 50-50-0, and 0-100-0 (composts with 0; 12,5; 25; 50, and 100% of biosolid). They were applied in the soil, creating 6 treatments: treatments with compost and control (just inorganic fertilization). The control and 0% of biosolid treatments received inorganic nitrogen, what for all treatments had the same amount of N, P, and K. After this, two tomato plants was cultivated in each 24-L pot, in acclimatized green house belong Biogeochemistry Laboratory's of Technology Dept. in the UNESP-Jaboticabal. The experiment had a subdivided parcels scheme, in randomized blocks. It was analyzed Cd, Cr, Ni and Pb concentration during the composting process (7, 27, 57, 97, and 127 days after compost mounting), this metals concentration in the soil (0 and 164 days after pots fulfill), the concentration and uptake in the plant. The materials were submitted to digestion with HNO₃, H₂O₂ and HCl and the metals were determined by AAS. There were negative correlation between Cd, Cr, and Pb in the compost and Cd, Cr, and Pb plant uptake, as well as Ni in the compost and Ni concentration in the plant (-0,53; -0,59; -0,53, and -0,52, respectively, $p > 0,05$). The Cd, Cr, Ni and Pb levels increased with composting process. Just Cd levels increased when applied compost in the soil. The roots absorbed Cr, Ni and Pb. The stem and leaves, Cd and Ni. The fruit do not absorbed any studied metals. The composts with biosolid do not improved Cd, Cr, Ni, and Pb uptake in the plants.

1340-1440

S10-P-44

INFLUENCE OF A FLAVONOID (FORMONONETIN) ON MYCORRHIZAL ACTIVITY AND POTATO CROP PRODUCTIVITY IN THE ALTIPLANO OF PERU

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Mycorrhizal fungi serve as biofertilizers, reduce plant stress, and can increase plant productivity. It is highly desirable to utilize native mycorrhiza in sustainable agriculture systems. Since the potato originated from the altiplano of Peru and Bolivia, a goal of this research was to use indigenous Peruvian mycorrhizal populations to enhance crop productivity in a subsistence production site. The field study was conducted to test the effectiveness of the flavonoid, formononetin, to stimulate native mycorrhizal activity and subsequent yield of six Andean potato (*Solanum tuberosum* L.) selections. The site was located at an altitude of 3900 meters in San Jose de Aymara (Dept. of Huancavelica), in the central altiplano of Peru. This is approaching the highest altitude in the world that potatoes are grown. The site was a sandy-loam soil with pH 3.6, and low phosphorus (P) availability. Prior to planting, the site had been fallow for a minimum of 15 years. Tubers were planted in November 1999, just before the beginning of the rainy season. Minimal organic fertilizer was applied and the potato crop received no supplementary irrigation. Formononetin was applied as a soil drench when shoots began to emerge. At the end of the six-month study, four of the six cultivars had either increased potato tuber dry mass and/or greater no. 1&2 grade tubers. Formononetin increased soil sporulation of indigenous mycorrhizae. The predominant mycorrhizal genera were *Gigaspora* and *Glomus* spp.

1340-1440

S10-P-45

COMPARISON OF EFFECTS BETWEEN FOLIAR AND SOIL N APPLICATIONS ON SOIL N AND GROWTH OF YOUNG GALA/M9 APPLE TREES

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The increasing concern about environmental contamination of nitrate leaching from agricultural land encourages looking for a more efficient way to apply N fertilizers. An experiment was carried out to compare the effect between foliar and soil N application on plant growth performance and soil nitrogen status in order to evaluate N use efficiency. One-year-old uniform Gala/M9 apple trees were selected and transplanted into 4-L pots with loamy sand soils. The plants were growing in the greenhouse and randomly divided into five groups with 17 trees in each group. The experiment included a control (no N) and 4 N treatments where the same amount of N as urea was applied biweekly as the new shoot grew about 5 cm long. N was applied by 1) foliar only, 2) soil only, 3) soil early and late, foliar midsummer (combination I), or 4) foliar early and late, soil midsummer (combination II). The new shoot number was counted, and shoot length, plant and soil N nutrients were measured during the season. Shoot number was unaffected by treatment, but soil N application significantly increased shoot length growth. All N treatments significantly increased leaf N status and leaf color (as indicated by SPAD-chlorophyll readings) compared with the unfertilized control, but there were no significant differences among different N treatments. Both soil NO³⁻ and NH⁴⁺ were significantly increased by soil N application compared with either control or foliar application, an indication that soil N application creates a higher potential of leaching loss.

1340-1440

S10-P-46

INVASION OF A NEW ENGLAND WOODLAND BY *EUONYMUS ALATUS*: A CASE STUDY OF OVENS MOUTH PRESERVE, BOOTHBAY, MAINE

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Euonymus alatus (winged euonymus) is increasingly recognized as invasive in woodlands of the eastern U.S. However, there is little documentation of invasion sites. This information is needed to establish criteria for judging inva-

sive potential and formulating management strategies. *Euonymus alatus* is invasive at Ovens Mouth Preserve, a nature preserve managed for recreation and wildlife habitat in coastal Maine. A former homestead, the 46-acre peninsula reverted to woods in the 1930s and stands are now dominated by either white pine (*Pinus strobus*) or red oak (*Quercus ruber*). *Euonymus alatus* is present at the site under the white pine canopy in dense thickets, smaller clumps, and as scattered individuals. To establish the extent of spread at the site, all stems of *E. alatus* intercepting 10 transects, each 150 meters in length, were counted and sampled for height, spread, and reproductive status. Biotic and abiotic variables were correlated with *E. alatus* presence or absence in sixty plots, (30 with *E. alatus*, 30 without *E. alatus*) along the established transects. Plots were sampled for soil moisture, pH, and nutrient availability; species composition; and basal area of tree species within a 5 m radius of plot center. *Euonymus alatus* is not currently found at the site in an area dominated by a red oak canopy/low bush blueberry (*Vaccinium angustifolium*) understorey. To determine the relative ability of *E. alatus* to succeed in the as yet uninvaded habitat, 2-year-old liners of *E. alatus* 'Chicago Fire' were planted in study plots in 3 habitats: white pine community, red oak/blueberry community, and a transition zone with white pine and red oak, but no blueberry. Plots were sampled for biotic/abiotic variables as stated above. Transplants were harvested at the end of the growing season and dry weights compared. Results of these studies will be reported.

1340-1440

S10-P-47

GROWTH STIMULATORY SUBSTANCES FOR MYCORRHIZAL FUNGI IN COMPOSTED ORGANIC MATTER

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We reported that although the application of raw organic matter to the soil severely inhibited vesicular-arbuscular mycorrhizal (VAM) development, fermented organic matter stimulated VAM development and growth of citrus seedlings (Ishii and Kadoya, 1996). When we fractionated the 80% MeOH extracts of fermented and raw organic matter by using a flash chromatograph, both growth stimulatory and inhibitory substances for mycorrhizal fungi existed in every raw organic matter. After fermentation, however, the inhibitory effects on 100% MeOH fraction containing a great amount of growth inhibitory substances disappeared and the stimulatory effects on 25% MeOH fraction containing a great amount of growth stimulatory substances remained. When the liquid obtained from the fermented organic matter was applied to the trifoliolate orange-planted soils, every liquid treatment promoted root colonization and growth of trifoliolate orange seedlings (Ishii et al., 2000). In this study, we isolated and identified the growth stimulatory substances for mycorrhizal fungi in composted organic matter. The organic matter used was the leaves and stems of *Artemisia princeps*, *Cayratia japonica*, *Paspalum notatum*, *Stellaria media*, and *Trifolium repens*, and rice straw. The growth stimulatory substances in the composted organic matter will be shown in this congress.

1340-1440

S10-P-48

BIOMASS ACCUMULATION AND PARTITIONING OF EASTERN GAMAGRASS GROWN UNDER DIFFERENT TEMPERATURE AND CO₂ LEVELS

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Eastern gamagrass [*Tripsacum dactyloides* (L.) L.] is a robust, warm season, perennial bunch grass which is native to North America, Central America, and upper South America. It produces high yields of palatable and digestible forage with a protein content comparable to alfalfa. It exhibits tolerance to a wide range of environmental stresses and soil conditions including drought, flooding, aluminum toxicity and acid soils. It is an attractive species for use in sustainable agriculture because of its ability to penetrate compact soils and to reduce the runoff of nutrients and sediment to nearby streams, when planted as a buffer strip. It has been reported to have one of the highest photosynthetic

rates of any C₄ species but data on temperature x CO₂ interactions are lacking. This study was conducted to determine the potential effects of future increases of atmospheric carbon dioxide on growth, biomass accumulation and root/shoot carbon allocation under a range of growth temperatures. Eastern gamagrass (cv. Pete) plants were grown in 1 m³ bins containing sand:vermiculite (1:1), fertilized weekly with a complete nutrient solution in closed, transparent SPAR (Soil, Plant, Atmospheric Research) chambers maintained at 370 or 740 µmol/mol CO₂ and 20/14, 27.5/21.5 or 35/29 day/night temperatures, and allowed to develop from mid-May to mid-October. Two cuttings were taken during the season. During the final harvest, roots, crowns, and leaves from each individual plant were collected. Biomass accumulation of roots, crowns, and leaves increased with temperature. CO₂ enhanced accumulation was modest, restricted to shoots, and observed only at higher temperatures and later in development. Results suggest little effect of CO₂ enhancement on vegetative growth at realistically anticipated future CO₂ levels over the course of a single growing season, although the potential for a cumulative response was demonstrated.

1340-1440

S10-P-49

POPULARIZATION OF VAM INOCULUM PRODUCTION AND APPLICATION IN FARMERS' FIELD

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Beneficial effects of VAM fungi as efficient scavengers of nutrients and as biocontrol agents have been established beyond doubt in horticultural crop production. But the use of this fungi is limited by the non availability of its inoculum in large quantity.. This has been a bottle neck in popularization of the fungi for large scale application. Efforts have been made at Indian Institute of Horticultural Research, Bangalore to popularize this fungus in horticultural crop production at farmers level as a package of practice On-farm inoculum production and their application methods were demonstrated in villages Mallasandra, Tiptur, Avadesh Halli, Kesture, Srinivasapura, Veerapura, Anabe, Malur, Kithanahalli and Jettipalya around Bangalore. Demonstrations were carried out in three steps. First, solarisation of the soil was done by covering the soil for 3 weeks using plastic sheets. Starter culture of VAM (*Glomus mosseae*) was applied in close rows followed by sowing of ragi (*Eleusine coracana* L.), a popular millet. Earlier studies carried out by us showed that ragi was a very good host for VAM inoculum production. After twelve weeks the shoot was harvested up to ground level and used as the fodder. The root and the soil dug nine inches deep was used as the inoculum. More than 3 tons of inoculum was produced in 25 square meter area. Inoculum thus produced was applied in crops like banana and papaya cultivation. The farmers in all these villages were very much convinced about the usefulness of VAM inoculum application and they are propagating the production technique to other villages.

1340-1440

S10-P-50

POLLINATION REQUIREMENTS FOR PRAIRIE PURPLE AND WHITE PRAIRIE CLOVER, *DALEA PURPUREA* AND *D. CANDIDA*

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Prairie purple clover, *Dalea purpurea* Vent., and prairie white clover, *Dalea candida* Willd, are native, deep-rooted, warm-season herbaceous perennials being used in range and pasture seeding mixtures, especially with native grasses for reclamation of transportation corridors and surface mined areas and revegetation of marginal lands. Both species have the potential in the horticulture industry as ornamentals for home gardens. Because both species are legumes, they fix nitrogen and grass production is stimulated in the proximity of plants. They are nutritious and palatable for livestock and wildlife. Native Americans used the leaves for tea and chewed the roots. The density and efficiency of various pollinators on prairie purple clover and prairie white clover grown in southern Alberta, Canada, were studied. In *D. purpurea* 17 species of bees and 7 species of flies were identified as pollinators, while in *D. candida* 15 species of bees and 10 species of flies were identified as pollinators. Bees were the more common pollinators than flies on both plant species. The density of flowers over the season can be described as curvilinear. The rate of foraging by

pollinator species from raceme to raceme varied. The bees and flies foraged on the plants for about 8 h per day as flower longevity was about 12 h. A theoretical approach used to predict the pollinator population required to pollinate varying raceme densities shows that the population required varied by pollinator species and the number increased with increasing density. The pollination requirements of both species for seed production were established. Cross-pollination of flowers was required to achieve optimum seed set.

1340-1440

S10-P-51

PLANT WATER EXTRACTS: A NEW STRATEGY TO OVERCOME FE CHLOROSIS IN FRUIT TREES

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Iron (Fe) chlorosis of fruit trees have been traditionally controlled through soil or foliar application of synthetic Fe chelates. However, the increasing consciousness of the environmental hazards associated to their use has stimulated the development of alternative and sustainable agronomic strategies. In this study we have tested the hypothesis that vegetal extracts obtained from wild or cultivated herbaceous species may improve Fe nutrition and overcome Fe chlorosis of fruit trees (pear and peach) grown on lime soils. One-year old micropropagated plants were grown in pots on a calcareous soil and treated with plant extracts, either soil or leaf-applied. Plant water extracts were obtained from i) *Amaranthus retroflexus*, ii) *Beta vulgaris*, iii) *Chenopodium album*, iv) *Urtica dioica*, v) *Lolium perenne* and compared with synthetic Fe chelates applied to the soil (Fe-EDDHA) or the leaves (Fe-DTPA). Untreated control trees were present as well. In pear, application of extracts, especially *Amaranthus*, significantly increased chlorophyll content. The effectiveness of soil-applied extracts was generally increased by the addition of Fe sulphate. Autumn foliar applications of *Amaranthus* extracts and Fe-DTPA delayed spring shoot growth. However growth was generally increased by the application of plant extracts, in particular in the soil treatments. In peach, plant extracts from *Amaranthus* and *Urtica* were effective in overcoming Fe chlorosis.

1340-1440

S10-P-52

USE OF SOIL-APPLIED CALCIUM CHLORIDE TO DECREASE DISEASE SUSCEPTIBILITY IN PEAR

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The pear industry in Italy's northeastern Po river land lands suffers from important diseases such as bacterial fire blight (*Erwinia amylovora*) and fungus brown spot (*Stemphylium vesicarium*) infections which are difficult to control by chemical sprays. Salinity of the irrigation water, induced by sodium chloride, was effective in reducing the susceptibility of potted pear trees to fire blight (Toselli et al., in press). This positive effect was related to the increase in leaf sorbitol induced by water salinity and possibly related to a reduction of leaf osmotic potential. The goal of this experiment was to evaluate the efficacy of soil-applied calcium chloride in reducing the susceptibility of pear to both fire blight and brown spot. In two distinct experiments, carried out on one-year-old, potted pear trees of cv. Abbé Fetel/Quince C, the following treatments were compared in a completely randomized design with 6 replications: 1) control, well irrigated, 2) irrigation rate reduced by 50% of the control; and 3) full irrigation rate with water solution of CaCl₂ to obtain an electric conductivity of 8.3 mS·cm⁻¹. Treatments were imposed when shoot length was around 10 cm and continued for 45 days. Fire blight inoculation was applied on 3 apical leaves per shoot (3 shoots per tree), and the progress of leaf and shoot symptoms were evaluated after 3, 8, and 21 days. Brown spot inoculum was applied by spraying a fungus suspension of 2 10⁴ conidia/mL, and symptoms were evaluated as number of infected leaves. Irrigation water with salt at a concentration of 8.3 mS·cm⁻¹ as well as a 50% reduction of water supply were effective in increasing pear tolerance to both fire blight and brown spot as compared to

control trees well-supplied with fresh water. Salt water and the reduction of water supply decreased shoot length, increased specific leaf weight and decreased the leaf water potential as compared to control, although they did not clearly affect leaf osmotic potential.

1340-1440

S10-P-53

ALMOND WASTE: A NEW ECOLOGICALLY-FRIENDLY ROCKWOOL SUBSTITUTE IN TOMATO CROP

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Industrial residue is the woody endocarp of fruit. This material remain available as a waste product for which no important industrial uses have as yet develop and which until now have been incinerated or dumped without control. In this work, tomato plants were grown in plastic-house under semiarid condition in the southeast of Spain. The different agriculture systems, rockwool slab and almond waste bag, were carried out in order to optimise water and fertilizer use to decrease environmental contamination and increase quality of fruits. The research was concerned yield and quality of production for managing agriculture systems. Influence of both agrosystems was evaluated on production and fertigation parameters and discussed in relation to environmental factors. The results suggested there were no an important differences. Therefore, almond waste seems to be an acceptable alternative substrate as substitute for rockwool slab in soilless crops

1340-1440

S10-P-54

THE EFFECTS OF GROUND COVER MANAGEMENT ON APPLE PERFORMANCE DURING ESTABLISHMENT

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The objective of this study was to characterize the effects of wood chip mulch, herbicide strip and overall grass with and without both irrigation and nitrogen fertilizer on apple tree establishment. 'Red Mac' on Bud. 9 trees were planted in 1998 with trunk cross-sectional area, tree growth and leaf nutrients measured from 1999 to 2001, tree volume, yield and blossom counts measured in 2000 and 2001 and soil tests analyzed in 2001. Trees grown in wood chip mulch and herbicide strips had significantly better performance compared to trees grown in overall grass. Trees in the wood chip treatment outperformed those in herbicide in trunk cross-sectional area (TCA), tree volume, and tree growth. Trees in herbicide strips had the greatest yield. There were significant differences among the groundcover treatments for the soil parameters tested. Soil under the wood chips had the highest levels of potassium (K), the herbicide treatment had the lowest pH and overall grass had the lowest percent nitrogen ($\text{NO}_3\text{-N}$). Leaf analyses corresponded to the findings of the soil tests. Leaves of trees grown in wood chips had the highest levels of K and those grown in overall grass had the lowest leaf $\text{NO}_3\text{-N}$. Results from this study lead to the conclusion that wood chips are beneficial to the establishment of apple trees and may result in greater growth over trees grown in herbicide strips and overall grass.

1340-1440

S10-P-55

IMPACT OF CLIMATE CHANGE ON CROP WATER DEMAND IN THE OKANAGAN VALLEY, BRITISH COLUMBIA

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Horticulture in the semiarid, Okanagan Valley B.C., Canada, depends on irrigation. Our objectives were to determine crop water requirements under climate change scenarios and to compare predicted demand with current water use and supply. Methodology was developed to integrate crop water demand data with spatial climate and land use data. Equations for seasonal crop coefficients were developed. Equations to predict solar radiation, daily maximum and minimum temperatures from monthly data were also derived as a basis for estimating PET. Future climate data (Canadian Global Circulation Model-

CGMC1) were compared with 1969-1990 normals. Climate data were spatially downscaled from a 3.75 latitude x 3.75 longitude grid output through the PRISM (Parameter-elevation Regressions on Independent Slopes Model) to a 4 x 4 km grid. Land use data were acquired from a variety of sources and incorporated into a GIS and overlain with the PRISM grid to create unique polygon. Calculations of crop water demand were performed for each polygon. Crop water demand was totaled on a region and Irrigation District basis. Overall average predicted water use data for present day conditions were compared with values of expected water use to test the crop water demand model. Predicted values were slightly lower than expected values (745 mm/year vs. 820-1000 mm/year). This was attributed to the coarseness of the PRISM grid, which resulted in large elevation changes within cells and underestimation of temperatures. Total annual water consumption for the period 1996-99 reported by the major Irrigation Districts was reasonably similar to that predicted by the model ($46.9 \text{ m}^3 \times 10^6$ vs. $51.8 \text{ m}^3 \times 10^6$). Thus the model was considered adequate for prediction of effects of climate change. For the region as a whole, estimated crop water demand increased by 37%, from 745 to 1021 mm/year (80 to $110 \text{ m}^3 \times 10^6$) between the present day and the 2070-99 scenario.

1340-1440

S10-P-56

IMPACT OF FLYASH AS MEDIA AMENDMENT ON CHRYSANTHEMUM GROWTH AND DEVELOPMENT

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Flyash is a byproduct derived from power plants that use coal to generate electricity. Disposal of this byproduct has traditionally consisted of mounding the ash into piles and covering with topsoil or other suitable substrate for plant growth. To minimize environmental impacts, the electrical industry is developing alternative uses for this byproduct. Current uses include incorporation of flyash into concrete and brick products. One characteristic of this product, its water holding capability, makes it appealing to the horticultural industry. When incorporated into sandy soils, flyash increases the productivity of tomatoes. Commercial production of floriculture crops utilizes various rooting substrates. Many of these substrates contain peat moss due to its high water holding capacity. Recent questions related to environmental impact of peat removal have prompted researchers to investigate peat moss alternatives in rooting substrates. To determine if flyash might be a suitable alternative to peat moss in a commercial rooting substrate, an experiment was conducted to measure the impact of incorporating various rates of flyash into a commercial rooting substrate. In a completely randomized design, fifteen rooted chrysanthemum cuttings were transplanted into a commercial rooting substrate amended with flyash at 0%, 25%, 50%, 75%, or 100% on a volume-to-volume basis. Weekly plant heights, rooting substrate pH, and rooting substrate electrical conductivity were determined for each pot. After six weeks, final plant quality was assessed based on percent healthy foliage. The addition of flyash to the rooting substrate negatively impacted chrysanthemum growth and development. Plant death occurred with 100% and 75% flyash. Plant height and quality were reduced as flyash percentage increased. Rooting substrate pH increased beyond commercially acceptable limits as flyash percentage increased. Flyash appears to have little horticultural value for potted plant production.

1440-1500

S10-O-57

MYCORRHIZAL FUNGI ENHANCE ACCUMULATION AND TOLERANCE OF CHROMIUM IN SUNFLOWER (*HELIANTHUS ANNUM L.*)

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Chromium (Cr) is a heavy metal risk to human health, and a contaminant found in agricultural soils and industrial sites. Phytoremediation, which relies on phytoextraction of Cr with biological organisms, is an important alternative to costly physical and chemical methods of treating contaminated sites. The ability of the arbuscular mycorrhizal fungus (AM), *Glomus intraradices*, to enhance Cr uptake and plant tolerance was tested on the growth and gas exchange of sunflower (*Helianthus annuus L.*). Mycorrhizal-colonized (AM) and

noninoculated (Non-AM) sunflower plants were subjected to two Cr species [trivalent cation (Cr_3^+) {Cr(III)}, and divalent dichromate anion ($\text{Cr}_2\text{O}_7^{2-}$) {Cr(VI)}]. Both Cr species depressed plant growth, decreased net photosynthesis (A) and increased the vapor pressure difference; however, Cr(VI) was more toxic. Chromium accumulation was greatest in roots, intermediate in stems and leaves, and lowest in flowers. Greater Cr accumulation occurred with Cr(VI) than Cr(III). AMF enhanced the ability of sunflower plants to tolerate and hyperaccumulate Cr. At higher Cr levels greater mycorrhizal dependency occurred, as indicated by proportionally greater growth, higher A and reduced visual symptoms of stress, compared to Non-AM plants. AM plants had greater Cr-accumulating ability than Non-AM plants at the highest concentrations of Cr(III) and Cr(VI), as indicated by the greater Cr phytoextraction coefficient. Mycorrhizal colonization (arbuscule, vesicle, and hyphae formation) was more adversely affected by Cr(VI) than Cr(III), however high levels of colonization still occurred at even the most toxic levels. Arbuscules, which play an important role in mineral ion exchange in root cortical cells, had the greatest sensitivity to Cr toxicity. Higher levels of both Cr species reduced leaf tissue phosphorus (P). While tissue P was higher in AM plants at the highest Cr(III) level, tissue P did not account for mycorrhizal benefits observed with Cr(VI) plants.

1500-1520

S10-0-58

SOIL ORGANIC AMENDMENTS CHANGE LOW ORGANIC MATTER AGROECOSYSTEMS

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Soil organic amendments have become increasingly important for both horticultural and public policy reasons. Public policy often encourages the use of compost and other organic amendments as a way of recycling urban waste and reducing atmospheric carbon dioxide emissions. Use of organic amendments has increased, but the consequences of raising soil organic matter are not always certain. It is popularly assumed that adding more organic matter increases productivity. But published data show conflicting responses of crops to soil organic matter, and the mechanisms behind the observed crop responses are often unknown. Part of the difficulty in measuring the effect of organic amendments in agriculture is that most agricultural soils contain significant amounts of organic matter. Incorporating as much compost as is practical may cause only insignificant changes in soil organic matter. More measurable changes should be observed from the addition of organic matter to low organic matter soils. In California and other arid production regions, low soil organic matter has been a long-term characteristic of the ecosystem. Desert soils are a particularly interesting paradox, with soil organic matter contents below 0.5%; but yet desert regions can produce record yields for many crops. We are studying how all aspects of the agroecosystem change as soil organic matter is increased in low organic matter soils. The most immediate changes have been with soil microbes and pest species. Organic matter can increase both the food source and the predators for a species. Weed and nematode populations generally decline, as higher levels of soil organic matter favor their microbial predators. Increased microbial populations and improved soil water and nutrient holding can moderate soil nutrient fluxes.

1520-1540

S10-0-59

COOL SEASON VEGETABLE PRODUCTION TRENDS: A POSSIBLE SIGNAL OF CLIMATE WARMING

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There has been much discussion on the implication of climate warming on many factors, including food production. Climate models can be used to predict the effect of global warming, but is there evidence in yield data to suggest an effect of climate change? Cool season vegetables could be good indicators of changes, since they can be adversely affected by temperature extremes com-

pared to some warm season crops such as corn. Thus, effects from climate warming may develop first in these crops. The average yield per hectare for several cool season vegetables in Ontario, including cabbage and cauliflower, was examined over the past 60 years. Overall, yields increased from the 1940s until the mid-1980s. After this time, yields per hectare have decreased and appear more variable in spite of modern cultivars and production practices. Coincidentally, this has been the period of noticeably warmer climate. Are these changes in provincial yield data related to climate warming? Records in southern Ontario do indicate a general increase in average air temperatures. Part of the decrease in yield might be a result of other factors, such as drought, soil compaction, or changes in the levels of insects and diseases. However, these would be expected to also change and interact with climate warming. Implications of these observations will be discussed.

1540-1600

S10-0-60

IRRIGATION AND PRUNING AFFECT GROWTH AND WATER USE EFFICIENCY OF TWO DESERT-ADAPTED SHRUBS

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Amenity landscapes often require supplemental water application in situations of low soil water availability, such as in root restricted urban settings, during unusual or seasonal periods of low precipitation, or in arid regions where irrigation is essential year round. In the arid western United States there is growing public concern about the viability of long-term water resources. Recent trends in landscaping include use of drought-adapted plants in low water use landscape designs, and some municipalities restrict use of turf and offer incentives to convert to xeric designs. Paradoxically, planting schemes and maintenance practices often include excessively dense plantings and over irrigation of xeriphytic species, which must then be severely pruned to reduce over crowding and obstruction of roads and walkways. Water use efficiency (WUE) of two Southwest landscape shrubs, *Nerium oleander* and *Leucophyllum frutescens*, was determined in a field study in response to 2 × 3 factorial treatment of irrigation volume (high or low volume) and pruning frequency (every 6 weeks, 6 months, or unpruned). WUE was defined as the ratio of total biomass produced to volume of irrigation water applied for one year. Plant biovolume was measured before and after every pruning event or every 3 months. All biomass pruned from plants was weighed, and after 1 years growth, 12 unpruned control plants of each species and irrigation treatment were harvested to determine allometric relationships between standing biovolume and standing biomass. Greatest total biomass production occurred for plants receiving the high irrigation volumes or plants left unpruned. WUE was highest for unpruned plants receiving low irrigation volumes and was lowest for 6-week pruned plants receiving high irrigation volumes. These data suggest that frequent shearing of well-watered plants lowers plant water WUE.

1600-1620

S10-0-61

COMMERCIAL NURSERY IRRIGATION AND FERTILIZATION SYSTEMS FOR MINIMAL ENVIRONMENTAL IMPACT

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Regulations regarding the use of water and concerns for ground and surface water pollution have resulted in Florida nursery and greenhouse plant producers seeking irrigation and nutrient delivery systems that minimize negative environmental impacts. In view of this, irrigation and nutrient management systems that result in minimal environmental impact were installed and evaluated in commercial greenhouses in central Florida. Systems evaluated included 1) capillary wick containers, 2) capillary mats, 3) water collection reservoirs beneath individual containers, and 4) water collection trays beneath 42 containers. These systems were compared to traditional overhead water delivery. Results indicate that less water is applied during plant production with capillary wicks than mats, although both systems require less water than overhead irrigation. For example, during a 2-month period in which *Calathea orbifolia* (Lind.) H. Kenn. were grown in 20-cm-diameter containers, plants irrigated with wicks

Tuesday August 13

and mats received about one-third and one-half, respectively, the water applied with overhead irrigation. Change in plant growth index during this time was largest for plants irrigated with wicks. In another evaluation, shade house-grown *Spathiphyllum wallisii* Reg. 'Ty's Pride' growth indices were similar when plants received controlled-release fertilizer on substrate surface of each container or solution fertilizer applied through overhead irrigation water. The total daily load of nitrogen to the ground beneath plants was largest for solution fertilizer applied through overhead irrigation. A summary of irrigation and fertilization management evaluations conducted during the past five years will be presented as well as implications with regards to nutrient management legislation.

1620-1640
S10-0-61-A
TO BE ANNOUNCED

1640-1700
S10-0-61-B
TO BE ANNOUNCED

Thursday · August 15

1100-1120
S10-0-62
ORGANIC TREE FRUIT PRODUCTION IN A SEMIARID CLIMATE

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Organic tree fruit production has gone from obscurity to a vibrant and commercially viable alternative to conventional growing in southern British Columbia and Washington. Unlike more humid areas, management of diseases, insects and mites is relatively easy. However, both positive and negative surprises and challenges in this regard continue to occur. Maintaining and improving soil nutrition, especially with increasingly scarce resources, is a priority. Irrigation is a necessary component of tree fruit production in such climates. While no negative effects have been documented to date, if the drying trend continues, more efficient as well as effective methods may have to be found. Development of less labour intensive methods of fruit thinning have become necessary as the availability of labour and the profits decline. Vegetation management continues to be tillage based but there is a growing recognition that research is needed to assess the impact of that. Socioeconomic factors affecting the growth of organic production remain both the major forces and biggest challenges in organic production. Research to find how the organic industry can continue to expand without falling prey to some of the factors that negatively affect the conventional industry is needed.

1120-1140
S10-0-63
ORGANIC FRUIT PRODUCTION IN HUMID CLIMATES OF EUROPE: BOTTLENECKS AND NEW APPROACHES IN DISEASE AND PEST CONTROL

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The organic market has grown exponentially in Europe during the last ten years. However, the organic fruit industry has shown the lowest growth rates (1% to 5% market share) compared to other commodities. Conventional fruit growers still hesitate to respond to the high market demand. One major reason is the high production risk due to diseases and pests in humid climates. The key pests and diseases in apple and pear include scab, sooty blotch, fire blight as well as rosy apple aphid, pear sucker and codling moth. In cherry, damages due to monilinia and the cherry fruit fly make an organic production almost unfeasible. In an ideal organic production system, all possible measures that lead to improved stability of the system have to be implemented. In fruit production, such measures include i) resistant varieties (scab), ii) active promotion of predators (rosy apple aphid),

iii) sanitation (cherry monilinia), iv) improvement of the microclimate (planting density, coverage of trees), and v) strengthening of the plant self-defence system (building up of soil fertility, biodynamic preparations). At present, most organic orchards have been designed for conventional production and therefore lack most of these stabilising components. Therefore, organic fruit production still depends largely on direct pest and disease control methods. These include traditional pesticides such as copper, sulphur, and lime sulphur (scab), pyrethrin, and oils and soap preparations. More recently, new compounds and techniques have been developed such as Neem preparations, granulosis viruses, and mating disruption to control pests. Progresses in disease control are less spectacular and focus to replace copper (e.g., with clay powders and resistance inducers). The introduction of new equipment, compounds and decision support systems will further improve yield stability. However, other limiting factors such as weed competition, crop load regulation and conventional market demands need innovative solutions.

1140-1200
S10-0-64
SUSTAINABILITY OF STONE-FRUIT PRODUCTION SYSTEMS

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There is a growing interest in organic and integrated farming systems because they are considered more sustainable and have the potential to reduce some of the negative impacts of conventional agriculture. Israeli growers of organic fruits have noticed that early growth of organic fruit trees is slower than that of conventional ones, and consequently, their yields are inferior to conventionally managed trees. It appears that inadequate mineral nutrition is responsible for this phenomenon. The present study was planned to address this problem. Replicated plantings of peaches, nectarines, plums, and almonds have been established in Israel, in 1998. Three treatments were compared, all under Organic crop protection: 1) Control-chemical nutrition management. 2) Organic nutrition based on compost and organic fertilizers. 3) Organic nutrition based on compost and leguminous cover crops. In addition to developing an adequate nutrition protocol for Organic production of stone-fruit trees, our goals were to measure the sustainability of these organic and integrated fruit production systems. This included calculating the profitability of the systems and measuring the effects of the farming system on soil quality, including physical and chemical properties. The yields of treatment 2 are similar to those of the control, while those of treatment 3 were lower, probably due to nitrogen deficiency. The price premiums obtained by Organic produce more than covered for the increased cost of Organic nutrition, in both Organic treatments. Soil quality of the 2 Organic treatments improved, as reflected in soil organic matter content, nitrification capacity and soil penetrability.

1200-1220
S10-0-65
ORGANIC SYSTEMS OF PRODUCTION BRING NEW HORIZONS TO TRADITIONAL CROP PHYSIOLOGY

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Traditional crop physiology has majored on the effects of environmental factors on tree and fruit growth and development, in orchards or controlled environments, with adequate nutrition, water and good control of pests and diseases. This has undoubtedly led to greater understanding in the traditional scientific reductionist pattern. The advent of organic systems of production, however, raises new challenges for crop physiology, not the least of which is to attract funding for systems of production that are still seen by some as on the outer fringes. The real scientific challenges relate to the effects on tree growth and fruit development of less than complete insect and disease control, spray materials such as sulphur that are more phytotoxic than conventional fungicides and less than adequate nutrition. Fortunately progress has already been made in computer modelling of crop growth of apples and peaches but this will need to be considerably expanded to include pest, disease and nutritional modules, including root growth,

to adequately encompass the organic growing system. The wider issues raised by the organic farming community regarding sustainability are important for all of us to face with reasoned discussion based on sound experimental data if we are to be all-round environmental physiologists. We believe this is an exciting area of research, as it involves a more holistic approach to our science but brings with it particular challenges to insert scientific objectivity into areas where it has been somewhat lacking in the past.

1220-1240

S10-0-66

ECOLOGICAL APPLE PRODUCTION: A COMPARISON OF ORGANIC AND INTEGRATED APPLE-GROWING

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In 1995, an experiment was planted at Wdenswil for comparing organic and integrated apple production. The overall goal of this experiment was to develop a data set which allows for an objective comparison of the two production concepts. A holistic overall comparison of the two systems wanted to be addressed as well as selected aspects of the orchard system. The trial should allow for a better valuation of the potential of the two systems for producing marketable fruits under Swiss conditions and for the identification of comparative and practical arguments regarding the adoption of the appropriate system for a specific orchard situation. The approach of an on-station comparison with a split-plot design with 3 replicate blocks and the factors production system (1st factor) and variety (2nd factor) was chosen. Cultivars Boskoop, Pommes Cloche, Idared and Resi were planted on rootstock M9 at 3.4 by 1.4m spacing. The crop management was dynamically adopted every year according to the most advanced and for the in-situ situation appropriate technology that is permitted by the actual Swiss guidelines for these two production systems. Parameters of tree growth, fruit growth, yield and fruit quality, crop protection, economy and ecology were assessed. In 2001, additional analytical fruit parameters were measured and extensive sensory tests were performed. In 2001, a comparative study between organic, integrated and conventional apple production, performed in Washington State (USA) between 1994 and 1999 (Reganold et al., Nature 410:926-930) generated a lot of interest in the scientific comparison of apple production systems. The present paper is the first detailed scientific report of the comparison of organic and integrated apple production on European ground (94% of Swiss apple acreage is managed according to integrated and 5% according to organic guidelines. Conventional production is therefore lacking practical relevance and was not included in this trial). The paper will present details of the adopted crop management in the experimental plots. First results referring to tree performance, crop production, crop protection, economics and fruit quality are discussed jointly with conceptual aspects of such an on-station trial.

1340-1440

S10-P-67

ORGANIC FRUIT AND VEGETABLE PERFORMANCE IN MIDWESTERN U.S.

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Organic farming has increased to an \$8 billion industry in the U.S. and continues to expand about 20% annually. Iowa farmers reported 150,000 acres of organic production in 1999. Research from 1998 to 2000 in Iowa to evaluate natural soil amendment/composts and pest management for certified organic pepper and apple production demonstrated positive effects on yield and marketability. Organic vegetable yields were similar to conventional yields when composted turkey litter with an analysis of 2.2-2.8-1.5 N-P-K was applied at 112 kg N/ha. Hairy vetch (*Vicia villosa* L.) cover crops provided sufficient N for organic pepper growth, but yields were less than compost-fertilized plots. Regarding pest management effects, kaolin particle film and coloring bags were found to be effective in protecting apples from insect damage. 'Jonafree' apple leaves treated with kaolin particle film and coloring bags had less insect damage and disease throughout the growing season and at harvest. There was no effect of treatment on beneficial insects. Overall quality was improved in 'Jonafree' apples where coloring bags or kaolin particle film was used. There were no significant differences in coliform, *E. coli*, yeast and mold populations in organic and conventional apple cider samples in 1999 and 2000.

1340-1440

S10-P-68

COMPARISON OF CONVENTIONAL, ORGANIC, AND NATURAL AGRICULTURAL VEGETABLE PRODUCTION SYSTEMS

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Whole system analysis compared three vegetable production systems: conventional (C), organic (O), and natural/control (N). Each system was treated as an independent ecosystem, receiving appropriate cultural practices for fertility, insecticide, and herbicide treatments. Over 5 years the project will track trends in soil chemical, physical, and biological changes; growth parameters for five summer and five winter crops; insect diversity; and plant nutrient changes. After three years, 1999 to 2001, yield has varied between systems depending on the crop and season. Vegetative biomass production followed the same pattern as yield. Organic matter declined in the O and C systems; nitrogen levels declined in the C and N systems, remaining stable in the O system. Insect populations in the summer 2000 plots showed that the C system has the least diversity and least amount of beneficials with the N system having the highest diversity. O has the highest number of beneficials overall and lower incidence of pests.

1340-1440

S10-P-69

EVALUATION OF CONTROLS FOR FLEA BEETLE ON EGGPLANT IN AN ORGANIC PRODUCTION SYSTEM

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Limited research-based information on pest controls used by and/or approved for organic growers has constrained the ability of Cooperative Extension to provide technical support for this small but growing component of New Jersey agriculture. This project was undertaken to begin addressing this need. Materials and techniques for controlling flea beetle on eggplant were evaluated in 2000 and 2001 under field conditions that conformed as much as possible to the organic production requirements of the Northeast Organic Farming Association-New Jersey. Infestations of aphids (2000) and potato leaf hopper (2001) allowed evaluation of the planned treatments for control, of these pests, as well. In 2000, Admire, a conventional material prohibited in organic production, provided total aphid control and reduced flea beetle damage at the end of the season. Rotenone, approved for certified organic production, controlled aphids and reduced flea beetle damage. Pyola, a material with potential for organic production, reduced aphid populations and flea beetle damage compared to the untreated control, but was not as effective as Rotenone. Surround, a formulated kaolin clay approved for certified organic production, did not control aphids but did reduce late season flea beetle damage. Aphid population under row cover was higher than the untreated control. Admire and Rotenone plots gave the highest total and marketable yields. Percent marketable yield was reduced by the Surround treatment. Plant growth, estimated by height and volume, was greatest for Admire and Rotenone treatments. Row cover provided an early season advantage for growth. The Surround plants were smaller than the untreated control plants by the end of the season. In 2001, Admire, Rotenone and Surround treatments were evaluated for pest control under the same conditions as in 2000. Pest control, plant size and fruit yield data will be presented.

1340-1440

S10-P-70

USE OF ORGANIC APPLICATIONS TO INCREASE PRODUCTIVITY OF HIGH DENSITY APPLE ORCHARDS

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Minimizing use of agrochemicals in fruit growing is a goal of integrated fruit production (IFP). Recently, a range of nontraditional organic materials,

including various municipal and agricultural composts and organic wastes have been advocated for possible use in IFP. Over the past decade, 10 randomized, replicated field trials were established in grower and research orchards in British Columbia to test the effectiveness of a wide range of organic materials when applied to the soil surface as mulches or mixed to 30 cm depth as soil amendments. Orchards were primarily high density apple on dwarfing rootstock, irrigated and grown on coarse-textured, low organic matter soils typical of the semiarid fruit production region of Pacific Northwestern America. Locally available organic sources exhibited a wide range of nutrient content, salinity, pH, cation exchange and water retention capacities. A potential for beneficial (and some detrimental) effects on fruit tree growth was indicated in preliminary greenhouse studies. In the field, the most consistent short term effect was improved growth associated with surface mulches of any kind. In the longer term, organic mulches may be preferable to geotextiles or herbicide application alone, both of which decreased soil microbial diversity. In a long-term field trial, cumulative yield of apple after 7 crop years increased as a result of mulching but also after periodic addition of biosolid even though year to year benefits resulting from this organic amendment was small. However growth or yield response to soil amendment was not measured at all sites. At these sites lack of effect was attributed to fertile soils, a strong grower fertilizer regime or failure to ameliorate a major limitation to growth despite generally improving orchard soil characteristics favorable for tree growth.

1340-1440

S10-P-71

WEED MANAGEMENT METHODS OF ORGANIC CARROT

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We are comparing 14 combinations of mechanical and also physical weed management techniques for organic weed management of carrot. Crop of our weed management research is carrot because of its difficulties in weed management (long growing period, poor weed tolerance) and because carrot needs to be important product of organic farming. We are using herbicide treatment as control-cultivator, weed brush, hoe, hand weeding for mechanical control and flame weeder for physical control. We have measured covering of weeds and carrot. We would like to show the results of last two years from our long-term experiment. Results of the year 2000 showed that weed brush is the best in interrows for keeping clean but in 2001 cultivator combined with hand weeding in rows seems to show the best results. We can see in this example that agriculture and weed management depends very much on the weather of the year, but we try to evolve a method, which can be generally used for organic weed control of carrot. OTKA T 030346 funded this experiment.

1340-1440

S10-P-72

EXTRACTION OF A LIQUID ORGANIC FERTILISER FROM POULTRY MANURE FOR USE IN FIELD AND SHELTERED HORTICULTURAL PRODUCTION SYSTEMS

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Organic horticultural production in Australia is currently limited by the inability of growers to readily apply sufficient available nutrients to crops. This limitation is primarily due to the majority of fertilizers used in conventional horticulture being incompatible with organic production systems. The system uses aerobic decomposition to rapidly (4 hours) release elements from a mixture of poultry manure and sawdust into a soluble form, which is then pumped directly into irrigation systems and onto crops in the field. The liquid manure was evaluated in a range of horticultural systems and yield, quality, and food safety issues monitored. The liquid manure produced growth in broccoli seedlings equivalent to conventional fertigation. When the manure-grown seedlings were planted into the field, they produced significantly higher yields than conventionally grown seedlings. In a separate field experiment, the liquid organic fertilizer was applied to field-grown broccoli using trickle irrigation and these plants produced higher yields than plants grown using conventional inorganic nutrients. The liquid manure was also applied to hydroponic tomatoes grown

in a run-to-waste system, producing fruit with higher Brix%, improved taste and higher overall acceptability compared to conventional sheltered tomato production. The results from this research indicate that the liquid manure is viable source of soluble nutrients for organic and conventional production, that has produced equivalent or superior yields than conventional production in nursery, field and sheltered production systems.

1340-1440

S10-P-73

ROOTSTOCKS AND SOIL MANAGEMENT IN ORGANIC APPLE PRODUCTION

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Soil management is a critical aspect for apple (*Malus x domestica* Borkh.) production. In organic production the development of alternative methods for weed control and for the supply of the necessary amount of nitrogen at the right moment with minimal losses of nitrate into the ground or decrease of production, is a key aspect for its sustainability. A total of 468 trees were planted in May 2000 at Clarksville Horticultural Research Station, under the organic certification protocol, to evaluate their performance. The apple trees of the cv. 'Pacific Gala' are grown following the vertical axe system and have drip irrigation. They are grafted on the rootstocks Supporter 4, M.9 RN 29, and M.9 NAKB 337 that represent three different levels of vigor: semidwarf, dwarf and weak dwarf respectively. Three ground floor management schemes randomly imposed were designed to reduce weed competition and to supply adequate nitrogen from several sources (alfalfa hay, clover, bell beans). The practices for weed suppression include flaming of weeds, mulching with alfalfa hay, or a strip tilling at each side of the tree rows (Sandwich system). In this last treatment legumes are seeded in fall. Trunk cross sectional area, branch growth, nitrogen levels in soil and plant, and soil cover parameters have been measured. The rootstocks as well as the treatments influenced the growth of the trees. Supporter 4 had significantly the greater growth, followed by M.9 RN 29, and M.9 NAKB 337. In the case of the soil management treatments the differences were even more significant. No significant interaction appeared between rootstocks and treatments. The possibility of achieving a satisfactory plant growth under variable limiting conditions using more vigorous rootstocks will be discussed.

1440-1520

S10-O-74

RESEARCH NETWORKING TO EVALUATE THE SUSTAINABILITY OF HORTICULTURAL PRODUCTIONS SYSTEMS

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Although it is widely recognized by agricultural system's researchers that evaluating the sustainability of agricultural production systems is vital, few studies of this nature have been published. One difficulty may be in defining what constitutes sustainability and how it should be measured, while another may be in networking with the necessary multidisciplinary research team to carry out this type of study. Using the recent study on the sustainability of apple production systems (organic, integrated, and conventional) in Washington State as an example (Nature 410:926, 2001), we will address the following critical questions about evaluating sustainability and how research networking fits into this scientific approach: What constitutes a system's approach to studying sustainability in horticulture production systems? Why are system's studies important? What are the characteristics of a successful system's study? Why aren't more system's studies performed or reported in the literature? What are the future directions of system's research?

1520-1540

S10-O-75

RESEARCH DIRECTIONS FOR ORGANIC TREE FRUIT PRODUCTION IN NORTH AND SOUTH AMERICA

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Organic pome and stone fruit production in both North and South America expanded dramatically during the 1990s in response to growing consumer demand for certified organic foods. Nearly all production is located in the semi-arid regions where disease and insect problems tend to be significantly less. Tree fruit producers and researchers in more humid regions are attempting to develop viable organic systems for their climates. Key challenges for producers in all regions include crop load management (fruit thinning), effective and economical weed control, fertility management, and control of replant disease. Insect pest problems vary by region, with some pests such as codling moth being a nearly universal problem. Advances in insect pest IPM for conventional production have directly helped organic producers. Researchers are focusing more attention on ecological design concepts and techniques to minimize pests and provide other benefits to the system.

1540-1600

S10-O-76

ORGANIC PRODUCTION OF KIWIFRUIT AND APPLES IN NEW ZEALAND: CURRENT STATUS AND FUTURE PROSPECTS

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Certified organic production of kiwifruit and apples in New Zealand has increased dramatically over the last decade. In the 1980s the kiwifruit industry's IPM programme (KiwiGreen) was used as a stepping stone to full organic production by up to 10% of growers. The reduced costs of herbicides on organic kiwifruit orchards are offset by increased costs of Bt and mineral oil sprays so that production costs are 10% to 20% higher on organic orchards compared with IFP orchards. Yields from organic kiwifruit orchards are typically 25% less than IFP orchards and fruit size is usually two count sizes smaller. The premium for organic fruit in the marketplace over conventionally grown fruit was as high as 89% in the early 1990s, resulting in net returns for organic production that were 17% higher. However in the current selling season the premium for organic kiwifruit has declined to only 15% over IFP fruit—insufficient to keep the category economically viable according to growers. Organic production of apples in New Zealand increased from only two orchards in conversion producing 23,000 cartons in 1996–97 to about 120 orchards either in transition or fully certified producing 1.5 million export cartons in the 2001–02 season, representing 9% of total apple production. The remainder of the apple crop is grown according to New Zealand's IFP principles. During this period the research focus has progressed from finding acceptable crop protection technologies for organic apple production towards studying the impacts of sulphur-based fungicide programmes on physiological and economic sustainability.

1600-1620

S10-O-77

ORGANIC FRUIT GROWING IN EUROPE IN THE BEGINNING OF THE 21ST CENTURY

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Organic fruit growing in Europe has experienced remarkable growth rates since the mid 1990s. Southern states, especially France and Italy, growing also olives, citrus and chestnuts having the largest acreage. Mainly increasing interest of supermarket chains is responsible for this buoyancy. But also the availability of better plant protection products, e.g., granulosis virus and mating disruption against codling moth, Neem oil against Rosy Apple Aphid. State subsidies varying from zero to 1200 Euro ha/y in the EU-countries are for the conversion of horticultural production less decisive. Market share of organic table fruit is only 1% to 2%, reaching 4% to 5% in Switzerland. For Switzerland, we estimate a market potential of around 15% as achieved with organic vegetables. To get there, for several key problems better solutions have to be found, e.g., control of scab, fireblight, sooty blotch, brown rot, weed management, fertilisation and blossom thinning. Also the assortment of organically producible modern-standard varieties is not satisfying, in particular with stone fruit. Economics of organic fruit growing is comparatively healthy, however depends on 1/3 higher farm gate prices for the product. In Switzerland the

direct cost free benefit of organic orchards is 16% higher (11'661 Euro) compared to IFP; but labour hours exceed those of IFP by 7%, due to blossom thinning by hand, manual weed control and mice control. Supermarkets have a tendency to just substitute conventional with organic fruit when requiring disease susceptible varieties with no cosmetic blemishes. This can/does feed back to the growers resulting in substitutional production with disease and pest sensitive orchards managed with intensive "organic" spray and fertilisation programs. This certainly does not correspond with either the original concept of organic farming or with expectations of organic consumers. Thus, still a lot of development—also on the marketing side—has to be undertaken.

1620-1640

S10-O-77-A

TO BE ANNOUNCED

1640-1700

S10-O-77-B

TO BE ANNOUNCED

Friday · August 16

0800-0900

S10-P-78

HORTIPS—A NEW CONCEPT IN HORTICULTURAL TECHNOLOGY TRANSFER

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HorTIPS (Horticultural Technology into profits) provides ready access to sources of technological innovation for the English horticultural industry. Particular focus is given to the needs of small and medium sized growers. The pilot programme has 3 Phases. 1) identification of the major technical constraints inhibiting profitability in the industry; this resulted from a survey of trade press, published reports and discussions with each sector of the supply chain. 2) intensive web searching to find sources of information and its electronic publication; information from 750 hours of web searching was collated and posted at www.hortips.co.uk. 3) outreach to growers and their consultants through meetings, conferences, trade journals, web based communication including discussion boards and distance learning units. The HorTIPS Team unites expertise from universities, commercial consultants and grower organisations aiming to increase accessibility to knowledge. Progress is monitored by a Steering Group of leading growers. Electronic communication between Team members has been essential for information exchange, organisation and project management. Funding comes from government (Dept. for Environment, Food & Rural Affairs—DEFRA, London, UK), levy based organisations (Horticultural Development Council—HDC) and industry.

0800-0900

S10-P-79

EXPECTATIONS, PROJECT APPRAISAL AND FINANCIAL SUSTAINABILITY IN PROTECTED AGRICULTURE: NEW MODELS FOR DECISION SUPPORT SYSTEMS

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From a financial point of view, one of the most important problems for almost any horticultural farmer is to predict the future, profit expectations, above all, if the investment is very high as happens in greenhouses. In this situation, operations and resource management are basically under a controlled risk. On the other hand, production and resource prices could be considered properly as un-

certain parameters. Project appraisal using simulation and multicriteria methods is a useful technique to analyse both different feasible alternatives and critical parameters for financial sustainability. Our software PRAPPIS v2.0 has been developed combining Monte Carlo and Goal Programming techniques and has shown satisfactory results in this context. However, some methodological problems appeared because of technical relations between agricultural activities and the financial parameters that describe them. For example: a low production always means a decrease in part time hand labour in harvesting operations. In order to design an easy-to-use tool, an inference engine based on fuzzy logic has been developed for the PRAPPIS system. Users can introduce their financial parameters and then relate them using five options: very positive, positive, neutral, negative and very negative relations. For example, a neutral relation between parameter A and B has five inference rules thus: if A increases B must increase. This paper shows the statistical differences between traditional simulation, where parameters vary freely, and simulation using controlled relations. The statistical distribution of every financial result is a powerful tool for decision makers in horticulture where uncertainty is so high. In order to test our model, a standard subtropical greenhouse was selected. Green beans and cherry tomatoes were chosen in a 1 ha plastic parral structure. Theoretical and real technical and financial parameters were used for a five year project appraisal in an uncertain environment.

0800-0900**S10-P-80**

EFFECT OF SUMMER SOIL SOLARIZATION ON THE YIELD AND ECONOMICS OF FALL-PLANTED LETTUCE

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The effects of soil solarization on the yield and economics of several crops have been documented previously. These effects, however, depend on the environmental conditions at the specific location where this practice is used. Field experiments were conducted to evaluate the effect of summer soil solarization strategies on the yield and economics of fall-planted lettuce in Southern Louisiana. Solarization treatments were either clear or black low-density polyethylene mulch treated for at least 9 weeks during the summer. The mulches were applied with a plastic layer to standard raised moistened beds (22 cm high, 36 cm wide bed top) on 1.22-m centers. Clear, clear mulch spray-painted black, and black solarization treatments were then planted with 4-week-old lettuce transplants into the undisturbed solarized beds. In addition to the three solarization treatments, bare ground and black plastic mulch (installed in the fall with and without the application of soil pesticides) were used as control treatments. The influence of the treatments on soil temperature (10 cm depth) during the soil solarization period and the growing season were measured. The results indicate that the soil temperatures under plastic mulch solarization treatments were greater than the bare-ground control. In addition, a minimum soil temperature of 45 °C was maintained at least one hour during August in all preplant solarization plots (both clear and black plastic). There were no differences in disease incidence between the treatments in the first experiment. Yield data (head weight and quality) will be measured at harvest for four lettuce cultivars, and the economics of the solarization strategies will be evaluated by means of comparative partial budgeting and marginal analysis.

0800-0900**S10-P-81**

INTRODUCTION OF A BIOTECHNOLOGY PRODUCT TO REDUCE POVERTY AMONG THE SMALL-SCALE RESOURCE POOR FARMERS IN KENYA

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Proponents of biotechnology assert that this technology offers enormous opportunities to poor farmers and low-income consumers in developing countries. An attempt made by the Institute for Biotechnology Research (IBR) at Jomo Kenyatta Univ. of Agriculture and Technology (JKUAT) to introduce tissue cultured (TC) bananas to small-scale resource poor farmers in Kenya showed that biotechnology alone will not solve farmers' problems. A holistic approach is required to address the complex and interrelated problems that limit horticultural production in small-scale farming. TC bananas are higher yielding and produce better qual-

ity bunches than the conventional ones. Besides TC banana seedlings can be produced throughout the year under controlled environment, which guarantees availability of planting material even after a drought period when the conventional planting suckers are not available. TC banana seedlings are also disease free, which marks an end of the old practice where diseases and pests were past from one farm to the other through the conventional sucker. The premise in this study was that the advantages vested in TC bananas would raise farmer's income and reduce poverty. Scientist at IBR used Participatory Rural Appraisal (PRA) methods to introduce TC bananas to the small-scale farmers. PRA is a bottom up social science approach that involves farmers in decision making (giving great consideration to gender balance). PRA enables scientists to identify the farmers' profiles and establish the social issues that can hinder the technology from being accepted by the farmers. Two pilot districts in Kenya were selected for the study. The purpose of this paper is to present the results on an impact study conducted in the two pilot districts three years after conducting the PRA assessments and introduction of TC technology.

0800-0900**S10-P-82**

CONVERTING SMALL HOLDER VEGETABLE FARMS TO ECOLOGICALLY FRIENDLY PRODUCTION IN TROPICAL HIGH ANDEAN CONDITIONS

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Small holder vegetable farms of Cota in the Bogota plateau (Colombia) are typically one hectare or less in size. Although the climate allows for year-round production, the farmers live precariously due to a high dependence on external inputs, poor access to different sources of information on production technology and lack of control over prices. An interactive methodology for conversion to ecological farming practices based on the European prototyping experience was developed with the farmers. Differences with the European methodology include a more participatory approach for the diagnosis of restrictions to sustainability, as well as for the implementation of the conversion process. The latter is based on a step-wise procedure following ecological sequence, farmers' needs and capacities, and market demand. Upscaling the conversion process was studied by proposing an option for redesigning the landscape within the context of ecological production. Because ecological farming is based on observation and inference to understand the relationship between plants and their environment and so prevent future problems, the effects of actions must be looked at in the long term. The farmers were therefore required to go through a serious learning process in order to know how to implement ecologically sound agricultural practices. By combining their farming experience and knowledge of the area with scientific knowledge on soil microbiology, plant nutrition, pest and disease management including enhancement of biological control through the establishment of live fences, a viable methodology for converting farms has emerged. The interactive methodology not only provided the space for proactive participation by the farmers, but because they feel ownership of the process, its continuity is guaranteed. An interesting alternative is now available to improve the farmers' quality of life and income by supplying the growing niche for ecologically friendly produce in the local market.

0800-0900**S10-P-83**

EVALUATION OF YOUNG FRUIT TREE PERFORMANCE IN ON-FARM HILLSIDE TRIALS IN TRINIDAD AND TOBAGO

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In 1997-98 on-farm trials were established with small farmers in the Maracas/St. Joseph Valley, Trinidad and Tobago, to evaluate the potential of fruit tree crops to improve the sustainability of crop production on their hillside plots. This paper presents the results of an evaluation of establishment and growth of 3- to 3.5-year-old trees using quantitative methods on four farmers' holdings and a qualitative research approach with two farmers whose trees exhibited different levels of performance. All farmers chose to grow mango (*Mangifera indica* L. either cv. Starch or Graham. Three farmers also chose one of the following species—pomme cythere (*Spondias dulcis* Forst.), sapodilla (*Manilkara zapota* van Royen) or sour cherry (*Phyllanthus acidus* Skeels). Tree survival differed among

farmers and ranged from 43% to 100% all species. *Pomme cythere* trees were the tallest (4.42 m) followed those of mango (1.79 to 2.78 m), sour cherry (2.16 m) and sapodilla (1.77 m). Among the tree species, canopy depth, canopy width and stem girth followed similar trends. Fire, drought, planting material quality and the level of weed, pest and nutrition management influenced tree performance. Interviews conducted with two farmers revealed that access to cash and labour affected management practices and that gender and health status could also influence the availability of these resources.

0800-0900

S10-P-84

SMALLHOLDER AGROFORESTRY FRUIT PRODUCTION IN LAMPUNG, INDONESIA: HORTICULTURAL STRATEGIES FOR SMALLHOLDER LIVELIHOOD ENHANCEMENT

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Smallholder farmers in Lampung, Province cultivate 2–5 hectares of land producing both perennial and annual crops to meet their household and income needs. Soils across the province are inherently infertile. For a number reasons many smallholders are dissatisfied with commercial annual crop production and are interested in expanding their tree farming activities. Traditionally, smallholders cultivate a large number of horticultural fruit/vegetable species as well as timber species, rubber, pepper/coffee, oil palm and coconut. The production of pepper/coffee, rubber, oil palm and coconuts are/were strongly market oriented. In contrast, the production of horticultural species remains primarily traditional. The species involved in smallholder horticultural systems, whether indigenous or introduced, are only semidomesticated—the germplasm utilized is of local, unselected origin and largely propagated from seed; management practices and inputs are of low intensity. Furthermore, smallholders have poor access to market information or market channels, and limited knowledge concerning market opportunities, which are advantageous. The demand for horticultural products in Lampung exceeds current supply and proximity to Jakarta offers access to potentially lucrative markets. Smallholders have the basic skills required to transform their traditional subsistence horticultural systems into semi-commercial enterprises. To facilitate this process smallholders need assistance to 1) identify horticultural species appropriate for the biophysical conditions of Lampung and have a high market demand; 2) evaluate varieties of these species under smallholder conditions; 3) adapt vegetative propagation and other horticultural management practices to enhance smallholder production systems; and 4) develop permanent linkages between smallholders and markets for horticultural products.

0800-0900

S10-P-85

DEVELOPMENT OF AN OBJECT-ORIENTED FRAMEWORK FOR ENVIRONMENTAL INFORMATION MANAGEMENT SYSTEMS IN HORTICULTURE

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Within the project for 'Environmental Management in Horticulture' of the Technische Universität München a software concept of an environmental information management tool for horticultural systems is implemented. The target user group of the software are growers and horticultural advisors using the tool for system optimisation and documentation. The following requirements had to be taken into consideration in the design of the concept of this practical approach: Minimal effort in using the tool: typically labour intensive tasks like data processing and especially data collection should be handled by the computer as far as possible to minimise running costs of the system; Flexibility: as the interests in specific information regarding environmental performance of a system vary with the interested party (e.g., customer, grower, public authorities), the tool should be capable to provide this information in the desired form (e.g., environmental impact per crop, impact per area, etc.); Standardised interfaces: to facilitate exchange of data with other information resources standardised data exchange formats should be used. Resources of relevant data could be publicly available environmental information databases as well as

local data logging systems that collect data on machine usage for example; Transparency: as one of the main objectives of the tool is process documentation, also the methods and models used in the processing of these information itself should be open to the public. A fundamental task in developing a tool for information management concerns the representation and management of real-world information to abstract entities that can be handled by the computer. For this modelling purpose an object-oriented design approach was selected. In the paper the basic concepts of this framework model are presented considering the criteria mentioned above.

0800-0900

S10-P-86

PROBLEMS AND OPTIONS FOR SUSTAINABLE APPLE FARMING IN THE INDIAN HIMALAYAN REGION

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Apple cultivation is presently recognized for successful diversification of subsistent mountain agriculture into cash crop farming. In Indian Himalayan region socioeconomic conditions of marginal farmers have significantly improved during the past five decades. However, the sustainability of apple farming has become a matter of concern today both from ecological and socioeconomic point of view. The region faces issues like impact of climate changes and upward moving apple production zones. The pace of development through apple based farming system has started downward trend due to decline in the productivity of apple orchards. The decline in apple production has forced the farmers to look for viable alternatives for sustaining farm economy which are not possible in near future. In the present studies, several factors have been attributed to the declining trends in apple productivity like expansion of apple cultivation to marginal areas with the fluctuating abnormal climatic conditions, monoculture of Delicious varieties and declining standards of soil and water management in Northwestern Indian Himalayas. The studies and discussions with group of scientists, policy planners and progressive farmers could indicate production strategies covering second generation varieties, pollinisers, use of honeybees and other pollinators, scope of high density plantation and production of superior planting material and eco-friendly plant protection measures which have been opined to play a dominant role in future apple farming paradigms in Indian Himalayas.

0800-0900

S10-P-87

DISEASE TOLERANCE AND DELAYED DEFOLIATION OF TOMATO PLANTS CULTIVATED IN COVER CROP MULCH IS CORRELATED WITH ACCUMULATION OF SPECIFIC GENE PRODUCTS

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Vegetable production is heavily dependent upon high off-farm inputs of polyethylene (plastic) mulch, nitrogen fertilizer and pesticides. Such production practice potentially contributes to the unintentional environmental pollution with fertilizer and pesticides as well as water run off and erosion. In recent years, alternative agriculture practices have tested cover crops like hairy vetch (*Vicia villosa*) as on-farm biological inputs that have the potential to reduce erosion and the use of agrochemicals without impacting the yield or quality of the produce. Field-grown, fresh market tomatoes (*Lycopersicon esculentum*) cultivated in hairy vetch mulches were found to have reduced severity of disease and reduced defoliation as compared to the plants cultivated in plastic mulch. In order to understand the basis of these beneficial attributes, we used a molecular approach to test if increased disease tolerance and reduced defoliation of vetch grown tomatoes is directly linked to changes in the expression of specific proteins and gene products. We selected a battery of antibodies and select PCR products to quantify the levels of those proteins/RNAs that have been implicated in senescence and disease tolerance: large and small subunits of Rubisco, cytosolic glutamine synthetase, heat shock protein-70, binding protein, basic chitinase, and chloroplast photosystem proteins. The data indicated that vetch-grown tomato plants have a sustained accumulation of transcripts and proteins central to disease suppression (chitinase) and delayed senescence (Rubisco, GS) in addition to up-regulated levels of critical chaperones.

Thus, there is a definite, molecular basis for enhanced attributes in tomato plants grown in cover crop legumes.

0800-0900

S10-P-88

BIOLOGICAL CONTROL OF MYLLO CERUS SUBFACIATUS INFESTING BRINJAL (*SOLANUM MELONGENA* L.).

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Brinjal (*Solanum melongena* L.) is an important vegetable crop in India occupying about 4 lakh hectares of land. In Karnataka and other neighbouring states this crop is severely infested by the Coleopteran pest *Mylloceris subfaciatus*. This pest has assumed a major pest status often resulting in 100% crop loss. Chemical control methods are not successful in controlling the pest totally. Therefore, biological control methods were tried to control the disease. To start with methods were standardized to rear the pest in the laboratory. Adult weevils of *Mylloceris* collected on brinjal crop were reared on potted plants enclosed in wire mesh cages. Adults were sexed and individual pairs were enclosed in petri plates containing distilled water moistened filter paper for laying eggs and few pieces of brinjal leaves. The eggs laid on the filter paper and between the filter paper and the wall of the plate were made to hatch at 27 °C and 80% relative humidity. Individual larva immediately after emerging was made to nibble on the leaves and was then placed on the roots of brinjal seedlings grown in plastic pots to make available established roots for their feeding. Insecticidal crystal protein was extracted from *Bacillus thuringiensis* sub sp. *tenebrionis* grown on the sporulation medium. The specific activity of the insecticidal protein in 50 ml 48 h old culture containing 10–9 cells was 2.5 µg·mL⁻¹. Bioassay was standardized in replicated sets to test the insecticidal property of the toxic protein on *Mylloceris* larvae by soil drenching and root dip methods. Lethal concentration of *Bt* was determined by probit analysis. In soil drenching method, The LC₅₀ values were 0.00269 mg·mL⁻¹ and fiducial limit was 0.0014–0.0051 mg·mL⁻¹. In root dip method LC₅₀ value was 0.044936 mg·mL⁻¹ and fiducial limit was 0.0204–0.1105 mg·mL⁻¹. *Bt* is effective against *Mylloceris* grub infesting brinjal.

0900-0940

S10-O-89

THE GLOBALIZATION OF AGRICULTURE: IMPLICATION FOR SUSTAINABILITY OF SMALL HORTICULTURAL FARMS

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To globalize means to make worldwide in scope or application. We live in a global ecosystem; in this, we have no choice. Increasingly, all nations of the world share a global culture, a consequence of past choices. And, the economy has become increasingly global by choice. However, within the global ecosystem are boundaries, which give form and structure to natural systems. Within the global culture are boundaries, which define different human values and perspectives of reality. And within the global economy are boundaries, which allow nations to reflect the differences in their natural ecosystems and social cultures in the structure and functioning of their economies. The World Trade Organization (WTO) appears committed to removing all barriers to international trade, to achieve free trade, and thus, to removing all economic boundaries among nations. Once the economic boundaries are removed, cultural boundaries will become further blurred, and ecological boundaries will be left open to economic exploitation. Cultural and ecological diversity are considered obstacles to economic progress. A truly global economy will allow greater geographic specialization, greater standardization of processes and products, and thus, will allow global corporations to achieve even greater economies of scale. In a global agricultural economy, small farms will be replaced by large farms, which in turn will be controlled by giant multinational corporations. Small farmers quite simply will not be able to compete in a free market global economy. Many small farmers of the world rely on horticultural crops for their viability. Thus, the implications of globalization may be even more dramatic for horticulture than for most other agricultural sectors. But even more important, ecological and cultural boundaries are essential to the long run sustainability of agriculture. Thus, if all economic boundaries are removed, human society, at least as we know it, will not be sustainable.

0940-1000

S10-O-90

SUSTAINABLE HORTICULTURE

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Modern society demands products that are produced sustainably. Companies are entering a new phase in which integrated responsibilities for humans, economy and environment are becoming a necessity for good entrepreneurship. In other terms, sustainable within the dimension of people, planet and profit (triple P). Indicators could be a useful instrument to determine the level of sustainability of products or companies. Up till now the determination of sustainability in terms of the three P's is mostly restricted to companies or economic sectors. Sustainability in terms of chains is not developed or adjusted. For a complete view about sustainability it is important to consider the entire chain of a product. In this project a set of indicators for sustainability for the rose chain is developed. To develop indicators for sustainable development is it necessary to have a structured approach. The methodological framework used in this research combines a top-down with a bottom-up approach. The top-down approach derives indicators from general principles regarding on good entrepreneurship and from a literature analyses of existing methodologies and developed indicators for sustainable development. With the bottom-up approach, the opinion of various actors in the rose chain towards sustainability is stated. The top-down approach results in a preliminary list of indicators, which will be reduced by the use of selection criteria. The major selection criterion is that the indicators reflect the major themes regarding sustainable development. Furthermore the indicators must be sensitive to changes in the environment or in socioeconomic conditions that the indicators reflects. Other selection criteria are: the scientific validity and measurability of the indicators, the availability of data and communicative quality of the indicators. In this project the methodology to create a set of indicators for sustainable development is carried out for the production chain of roses.

1000-1020

S10-O-91

ECONOMICAL AND ENVIRONMENTAL ASPECTS OF INTEGRATED FRUIT PRODUCTION IN BELGIUM

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In the traditional production of apples and pears a lot of pesticides is used. As the use of pesticides has a negative impact on the environment and the health of the consumers the Belgian government decided to encourage the integrated fruit production. A premium per hectare was granted to the fruit-growers that use the integrated production method. In this method the grower uses fewer pesticides and only uses the pesticides that are allowed in the system. At the Centre of Agricultural Economics (CEA) the economical and environmental impact of the introduction of integrated fruit production was examined. Based on the data of the farm accountancy data network of the CEA the use of pesticides was compared on holdings using the integrated production method and those who still used the classical production method. It was found that the total use of active compounds of pesticides in the integrated production method was only two thirds of the use in the classical method. On the other hand the profitability of the holdings was examined. No significant difference in profitability between the holdings of both groups could be detected. The more when the profitability of the two groups was compared in the years before the integrated fruit production was introduced, no different developments of profitability between the holdings of the two groups was found. So it can be concluded that a more general introduction of integrated pit fruit production can lead to an important reduction of pesticide use, and that this reduction does not affect the income of the fruit holdings.

1020-1040

S10-O-91-A

TO BE ANNOUNCED

1400–1420**S10–0–92****NEED FOR LOW-PRODUCTION COST ALTERNATIVE SYSTEMS FOR FUTURE SUSTAINABILITY OF THE VEGETABLE GROWERS IN THE UNITED STATES**Aref A. Abdul-Baki*¹, Lidia M. Carrera¹, John R. Teasdale¹, Pamela K. Rice²¹USDA-ARS, SASL, 10300 Baltimore Ave., Bldg. 001, Room 245, BARC-West, Beltsville, MD 20705 USA; ²Dept. of Soil, Water and Climate, Univ. of Minnesota, 1991 Upper Buford Circle, St. Paul, MN 55108 USA

Future sustainability of the vegetable growers in the U.S. will depend upon their ability to cope with regulations imposed by the global market as well as their adoption of production practices that maintain soil fertility and high yields while conserving natural resources and protecting the environment. The conventional vegetable production system that has been used in the U.S. is a high input system that depends on tillage, a major inducer of soil erosion, and on chemicals such as commercial fertilizers, pesticides and nondegradable plastic mulches. These production components increase the production cost, deplete the natural resources, and contaminate the environment. Several alternative production systems with many specific advantages have been introduced. The most widely accepted are those that use no-tillage to reduce soil erosion in conjunction with cover crops to improve soil fertility by adding organic matter, fixing nitrogen, and recycling nutrients. Major improvements in cover crop management have been made by keeping the cover crop residues on soil surfaces and terminating chemically with herbicides or mechanically by mowing or rolling. This approach is effective in suppressing weeds and reducing soil moisture losses by evaporation. These alternatives have been

effective at reducing fertilizer and herbicide use in production systems as well as in reducing sediment and pesticide losses from fields.

1440–1440**S10–0–93****SUSTAINABLE AGRICULTURE THROUGH ECOLOGICALLY-BASED, “BUILT-IN” SOLUTIONS****NO ABSTRACT PROVIDED****1440–1500****S10–0–93–A****ABSTRACT UNAVAILABLE****1500–1540****S10–0–94****UNVEILING BASIC PRINCIPLES IN NATURAL TOLERANCE TO MICROBIAL PATHOGENS IN COVER CROP GROWN VEGETABLES****NO ABSTRACT PROVIDED****1540–1600****S10–0–95****TO BE ANNOUNCED**