

Cultural management and techniques



■ Comparison of avocado fruit maturity parameters of fruit grown under cool subtropical conditions

I. Bertling¹, O.O. Olarewaju¹, L.S. Magwaza²

¹. Horticultural Science, University of KwaZulu-Natal, Pietermaritzburg, South Africa

². Crop Science, University of KwaZulu-Natal, Pietermaritzburg, South Africa

Commercial maturity of avocado fruit is measured by various means in the avocado-producing countries of the world; such parameters include percentage mesocarp dry matter, percentage moisture (MMC) and oil content (MOC). While MOC is considered the most reliable maturity parameter, its determination is time-consuming. The value similar to MOC, dry matter, includes other substances besides oil. The reciprocal value to dry matter, percentage moisture, is often not well-correlated to percentage oil. Despite adhering to the regulation of a certain minimum maturity standard, fruit sometimes do not ripen properly, indicating immaturity. To determine if oil, dry matter or total soluble solids (TSS), as a measure of the mesocarp sugar concentration, can be used as reliable maturity parameters in 'Hass' and 'Fuerte' avocados, fruit from two cool subtropical farms were harvested throughout the 2014 growing season and the alterations in MOC, dry matter and % TSS determined. While moisture content of 'Hass' and 'Fuerte' fruit decreased over the half year observation period, dry matter increased, but MOC seemed to peak in August in the one location, while it had a tendency to increase up to the last harvest in the other. MOC was not as well correlated with any of the other parameters; mesocarp TSS was found to also not consistently increase with fruit maturity. Therefore, MMC and dry matter seem to be the most reliable maturity measures; however, as there was no peak in these parameters, the 'optimal maturity' as determined by palatability remains questionable.

■ Growing avocados under shadenetting in South Africa

R.J. Blakey¹, Z. Van Rooyen¹, J.S. Köhne¹, K.C. Malapana², E. Mazhawu², S.Z. Tesfay², M.J. Savage²

¹. Westfalia Technological Services, Tzaneen, South Africa

². University of KwaZulu-Natal, Pietermaritzburg, South Africa

There is a global trend to high intensity horticulture, including high density plantings, use of superior cultivars, greater plant manipulation, and protected cultivation. The avocado industry is lagging in the use of the latter.

Two shadenet structures were erected over existing orchards. The first in the warm, dry subtropical area of Mooketsi (Limpopo) and another in the cool subtropical area of Karkloof (KwaZulu-Natal), South Africa. At Mooketsi, the 1.0 ha orchard, planted to 'Mendez #1' ('Carmen'-Hass) on Dusa®, was covered with 20% white shadenet. At Karkloof, the 1.6 ha orchard, planted to '3-29-5' ('Gem®') on Dusa®, was covered with 30% clear shadenet. These orchards were selected because the fruit of these cultivars are of high value because they are earlier and later than 'Hass', and because of the contrasting abiotic stress factors at each location. Microclimate and various horticultural aspects were compared inside and outside the shadenetting structures. There was little difference in air temperature and relative humidity, but the shadenetting reduced afternoon canopy temperature was reduced by approximately 5°C, eliminated wind, prolonged leaf wetness after rain, and also reduced the rate of evapotranspiration.

The shadenet resulted in improved fruit quality due to reduced wind damage and sunburn, particularly at of the 'Carmen'-Hass' at Mooketsi. Concerns remain about bee activity and pollination but this is being addressed to be able to provide a holistic commercial recommendation. The study will continue for the medium term to also determine the financial viability of growing avocados under shadenet.

■ The potential for the production of “successful” fruit on ‘Hass’ avocado (*Persea americana* Mill.) trees is reflected by the carbohydrate content of the style

H. Boldingh¹, M. Alcaraz², T. Thorp³, P. Minchin⁴, N. Gould⁴, J. Hormaza²

¹ The New Zealand Institute of Plant & Food Research Limited, Hamilton, Nueva Zelanda.

² Instituto de Hortofruticultura Subtropical y Mediterránea La Mayora, (IHSM la Mayora-CSIC-UMA), Málaga, España.

³ The New Zealand Institute of Plant & Food Research Limited, Hamilton, Nueva Zelanda.

⁴ The New Zealand Institute of Plant & Food Research Limited, Hamilton, Nueva Zelanda.

Avocado trees (*Persea americana* Mill) can produce copious quantities of flowers but in comparison fruit set percentage is very low, even after hand pollination. Our hypothesis was that the carbohydrate and boron content of avocado flowers at anthesis affected the potential of these flowers to set fruit. ‘Hass’ avocado flowers in orchards in New Zealand and Spain were hand pollinated and 24 hours later, after pollen tube growth had occurred, the styles were collected and analysed for starch, individual sugars and boron. These data were later compared with the fate of the flower from which the style had been collected. Starch and all individual sugars were higher in the styles from flowers that successfully went on to set fruit. Boron content was significantly higher in the styles from flowers that successfully set fruit in New Zealand but no significant difference was observed in boron content of these styles from Spain. These data support previous findings that starch content of flowers at anthesis influences the probability of that flower setting a fruit.

■ Application of sequential statistical data-mining methods to determine tissue nutrient concentrations related to yield of the ‘Hass’ avocado

S. Campisi-Pinto^{1,2}, D. Crowley², P. Rolshausen¹, C. Lovatt¹

¹ Department of Botany and Plant Sciences, University of California, Riverside, CA 92521-0124, USA

² Department of Environmental Sciences, University of California, Riverside, CA 92521, USA

Plant tissue analysis completed sufficiently early in a growing season can identify nutritional problems in time to take corrective actions to safeguard commercial yield of perennial fruit crops. Leaf analysis is an established method for precision agriculture, however, with reference to ‘Hass’ avocado, leaf analysis may not provide adequate guidance for optimal yield, fruit size or fruit quality during the current or following season. For these reasons tissues other than leaves were collected and analyzed. The objective was to estimate the strength of the associations between yield and concentrations of N, P, K, S, Ca, Mg, Fe, B, Zn, Mn and Cu in the following tissues: cauliflower and full bloom stage inflorescences collected in March and April, respectively; pedicels collected monthly from fruit set through harvest, and spring flush leaves collected in September (industry standard). Samples were collected from six commercial ‘Hass’ avocado orchards located in the northern and Southern production areas of California for two consecutive crops. Sequential analysis of the data by statistical methods that included least squares multiple linear regression, principal component analysis and factor analysis provided evidence that cauliflower stage inflorescences may provide the best predictive and descriptive models for expected yield. Within this tissue, yield was significantly related to the concentrations of N, K, Mg, S, and Cu ($R^2 = 0.7075$; $P\text{-value} = 0.0002$). Envelope analysis was used to estimate the concentration ranges of each nutrient (% dry weight) in cauliflower stage inflorescences related to yields > 40 kg/tree: $2.77 < N < 3.60$; $1.70 < K < 2.15$; $0.18 < Mg < 0.27$; $0.25 < S < 0.32$; and $0.76 \times 10^{-3} < Cu < 2.15 \times 10^{-3}$. The utility of these values will be tested in the field.

¹ Present address: Plant & Food Research Australia Pty Ltd, Teneriffé – Brisbane, Queensland, Australia.

Ten years of experience on high density management in Michoacan, Mexico

G.Carrillo-Gallegos¹, V Calderón¹

¹. SIVA, Uruapan, Michoacán, México

The cultivation of Hass avocados grown in Michoacan since late 1960 has cultivated commercially. Plantations separation of 10-12 meters between trees were established, with planting densities ranging from 100 to 69 plants per hectare, currently having orchards with this density, which have been little affected by pruning reaching higher heights of 12.5 meters hindering all cultural activities and a significant decrease in the quantity and quality of fruit produced. These planting distance were maintained over several decades because in the first 10 years of the orchard good yields were obtained, and also to a widespread perception that the soil and climate of Michoacan are not suitable to handle more trees per hectare. However in recent years due to increased production costs, depletion of land suitable for cultivation has seen the need to increase the densities of planting in new orchards. In several municipalities of Michoacan are installed orchards with densities ranging from 400-555 trees Ha-1, having average yields in their first 5 crops 18.5 ton Ha-1 with maximum yields of up to 30 Ton-Ha-1. Is possible to increase the planting densities conventionally established, managing the highest density in those lower soils promoting the plant vegetative growth, while those that provide further development place the lowest density.

Current status and control recommendations for laurel wilt and the Ambrosia beetle vectors in commercial avocado (*Persea americana* L.) orchards in South Florida

J.H. Crane, D. Carrillo, R.C. Ploetz, E. A. Evans

University of Florida, IFAS, Tropical Research and Education Center, Florida, USA

Florida's US\$100 million avocado industry is threatened by laurel wilt (LW), a lethal disease of trees and shrubs in the Lauraceae that is caused by *Raffaelea lauricola* (Rf). The primary ambrosia beetle vector of Rf, *Xyleborus glabratus* (Xg) was first detected in a natural area ca. 41 km north of Florida's commercial avocado production area in March 2010. By February 2011 LW was confirmed in dying native swampbay (*P. palustris*) trees and by February 2012, LW had been confirmed in a commercial avocado orchard. Several other ambrosia beetle (AB) species, *X. volvulus* and *X. ferrugineus* are known to carry Rf and appear to be more important vectors of Rf under orchard conditions. Although AB are responsible for short and long distance movement of Rf, the most rapid spread occurs once LW is present in an orchard and spreads via root grafts among adjacent avocado trees. Recommendations for control of LW include: (1) early detection of Rf infected trees by frequent scouting of orchards; (2) sampling suspect trees for the pathogen; (3) tree uprooting, chipping of all wood possible and burning wood too large to chip and; (4) treatment of wood chips with insecticide. Additional recommendations include prophylactic infusion of propiconazole into avocado trees adjacent to infected trees or all trees in the orchard and periodic aerial insecticide applications to reduce AB populations. More information on the AB vectors, the LW pathogen and control recommendations and costs of control will be discussed.

Agro-climatic suitability and identification of productive niches with low risk of water shortage for avocado in Fresno, Colombia

F. E. Martínez¹, L. Y. Deantonio¹, E. Aguilera¹, G. Araujo¹, L. Ortiz¹, E. O. Rojas¹, F. Boshell²

¹. Corporación Colombiana de Investigación Agropecuaria, CORPOICA, Mosquera, Colombia.

². Asesor. Unidad de Agroclimatología. CORPOICA, Mosquera, Colombia.

Extreme weather events associated with climate variability ENSO (El Niño / Southern Oscillation) have caused significant economic losses Colombian agriculture. The identification of low exposure areas to agroclimatic threats becomes an important tool to planning agricultural land use and decreasing the vulnerability of crops to climate risks.

Identifying productive niches was made taking into account IPCC (2012) definition about agroclimatic risk based on crop exposure to climate hazards and crop sensitivity to water stress events. This analysis includes the FAO land evaluation methodology, water availability calculation using the PDSI index for the period 1980-2011 and a validation process with local stakeholders.

Analysis for growing Avocado (*Persea americana*) Hass and Choquette varieties in Fresno, Tolima, Colombia is presented. The modeling was performed taking into account the most sensitive phenological stages to water stress under normal weather, flooding and drought conditions, constructed from the characterization of climate variability in the area. It was found around 21819 ha with low agroclimatic risk to avocado under normal condition water. In flooding condition there are a significant reduction in potentially areas with lower agroclimatic risk to avocado (1419 ha). Finally, under drought condition, there are about 423 ha with low agroclimatic risk for growing avocado. This work approaches to the study of climate risk to planning agricultural land use in the territory.

■ Application of paclobutrazol in the yield of avocado growing cv. "Hass"

D. Felles Leandro¹, R. Quiñones Ramirez¹, E. Francisco Cajachagua²

¹. Universidad Nacional José Faustino Sánchez Carrión, Huacho

². Fundo Teolinda SAC, Sayán

Determine the dosage of paclobutrazol that decreases the shoot length and increases the number of fruit set, improve the yield and size of avocado *Persea americana* Mill. cv. Hass. Methods. It was used avocado plants of four campaign. The dosage of Paclobutrazol were: control 0 ppm (T0), 937.5 ppm (T1), 1875 ppm (T2) and 2812.5 ppm (T3). It was evaluated the size of the shoot length, the number of fruit set per plant, the polar diameter, the equatorial diameter of the fruit and yield per hectare. The design of a randomized complete block was used, with four treatments and three replicates. It was performed the Analysis of Variance and Tukey test for comparison of averages, with 5 % significance, using SAS Statistical Analysis System. Results. In shoots length the T1 has the smallest size of shoots with 34.5 cm statistically similar to T0 with 46.5 cm long. The number of fruit set showed highly significant difference between treatments ($p < 0.01$) the T1 with 124.75, higher to T0 with 105.25 fruits per plant. The polar and equatorial fruit diameter did not show significant difference between treatments ($p < 0.05$). The yield showed highly significant difference between treatments ($p < 0.01$), the T1 with 26.21 t.ha-1 statistically higher to T2 and T3 (21.76 and 17.13 t.ha-1), showed no statistical difference with the T0 (23.34 t.ha-1). Conclusion. The Paclobutrazol dosage of 937.5 ppm (T1), had better responses in the number of fruits, without surpassing statistically the T0 in shoot length and yield.

■ Intensive conduction systems in the profitability of avocado growing cv. Hass

D. Felles Leandro¹, J. Loayza Valdivia², J. Zúñiga Navarro¹, I. Gómez Echevarría¹, R. Felles Leandro¹

¹. Universidad Nacional José Faustino Sánchez Carrión, Huacho

². Instituto Nacional de Innovación Agraria, Huaral

Objective. Determine the intensive conduction systems in the profitability of avocado growing (*Persea americana* Mill) cv. Hass. Methods. It was used avocado plants of four campaign. The systems of conduction used were; Open-cup tester (T0), Mackenzie Pyramid (T1), Truncated Pyramid (T2), Hand span Longitudinal (T3) with densities of 48, 24, 24 and 12 plants in 150 m², respectively. The yield per hectare was evaluated and the profitability of the crop. It was evaluated the number of fruit export, the solids content and oil. The design of a randomized complete block was used, with four treatments and three replicates for the variables yield, percentage of dry matter and oil in the fruit. Tukey test was used for comparison of averages. The Chi-square test was used to assess the caliber of fruit. Results. The performance showed highly significant difference between treatments ($p < 0.01$), the T1 with 11.67 t.ha-1, It was statistically superior to the conventional system T0 with 8.67 t.ha-1 and statistically similar to T2. The number of exportable fruits showed no significant difference between treatments ($p > 0.05$). Regarding the percentage of dry matter and oil no significant differences were found between treatments ($p > 0.05$). The profitability indicator for the T1 was higher than the other treatments with (3.39). Conclusion. The conduction system Mackenzie Pyramid was the most profitable in the cultivation of avocado.

■ Effect of different timing of soil applied uniconazol on the production of avocados (*Persea americana* Mill.) Cv. Hass

F. Gardiazabal, F. Mena, J. Torres, A. Pinto

GAMA, Quillota, Chile

Hass avocados planted don Hillside at short distances (3x3 or 2,5 x 2,5 m) mean a higher competition between trees, nevertheless in order to maintain tree size under these planting distances, highly productive trees and lower alternate bearing is required. The use of soil applied Plant Growth Bio-regulators (PGB) avoid vigorous vegetative growth, maintaining the trees at heights no taller than 2 or 2,5 m. The dosage and timing of application of these products are essential to achieve the desired objectives.

The application of Uniconazol was tried on different months of the year (October, November, December, January and February) over two years. This trial was carried on Hass avocado trees grafted on Mexicola Seedling rootstock. Flowering (percentage of tree canopy covered with flowers and number of determined and undetermined inflorescences), crop per tree and fruit size was evaluated in 20 trees per treatment.

The experiment was laid out as fully randomized and data were analyzed by ANOVA. Mean values were then compared by Tukeys test, with statistical differences tested at $P \leq 0.05$. Results show that there are statistical differences on different application dates of Plant Growth Bio-regulator. There are differences on Flowering, fruit number and production (K/tree). The best dates showed to be November and October, being the first date statistically different to all other treatments.

■ Effect of different soil applied Uniconazol doses and different Uniconazol based products on avocado (*Persea americana* Mill.) Cv. Hass production

F. Gardiazabal, F. Mena, J. Torres, A. Pinto

GAMA, Quillota, Chile.

Managing high density avocados (3x3 m and 2,5 x 2,5 m), requires the use of Growth Bio-regulators (GBR) to maintain the trees within the desired size. In Chile, the use of Uniconazol (Sumagic®) is authorized for soil applications on Avocados. Nevertheless, the right dosage and the chance of having alternative Uniconazol based products as well as residue dissipation are key issues for the future development of these type of materials. Both trials were carried on Hass avocado trees grafted on Mexicola Seedling rootstock.

Trial 1: 2, 4 and 8 liters of Uniconazol 5p (5% a.i.) per hectare were tried for 3 years. The experiment was laid out as fully randomized with 3 treatments and 10 replicates by treatment.

Trial 2: 2 different types of Uniconazol (5% a.i.), at 0, 2 and 4 liters per hectare were compared for 2 years. The experiment was laid out as fully randomized with 3 treatments and 20 replicates by treatment.

For Both trials, Floral & Vegetative buds, production and fruit size were recorded. Data were analyzed by ANOVA. Mean values were then compared by Tukey's test, with statistical differences tested at $P \leq 0.05$. In Trial 1, all treatments were different in flowering, production, fruit sizes changed from year to year. In Trial 2, increases of dosage fruit per tree and total production were different. Fruit size and flowering changed according to production from year to year.

■ Effect of Cultar® soil applications, on productivity and development of avocados (*Persea americana* Mill.) Cv. Hass

F. Gardiazabal, F. Mena, J. Torres, A. Pinto

GAMA, Quillota, Chile.

Avocados have a natural growth habit of producing long and vigorous shoots in order to intercept light. This produces one of the main productive problems in avocados, orchard overcrowding in adult orchards. One way to reduce this problem is pruning, nevertheless after pruning vigorous regrowth causes overcrowding quickly again.

Soil applications of Growth Bio-regulators (GBR) are an excellent tool for maintaining tree size at very short planting distances (2,5 to 3,5 m) and to increase productivity in avocado orchards. This trial was carried on Hass avocado trees grafted on Mexicola Seedling rootstock over a period of four years. Treatments were the following:

Trial 1: Avocados irrigated with microsprinkler and wetted diameter limiter (1m diameter wetted area) on loamy soil, Treatments: Control, 2 and 4 L/ha of Cultar®

Trial 2: Avocados irrigated with microsprinkler without wetted diameter limiter (3,5 m diameter wetted area) on clay-loam soil, Treatments: Control, 4 and 6 L/ha of Cultar®

Trial 3: Avocados irrigated with drippers on sandy soil, Treatments: Control, 2 and 4 L/ha of Cultar®

During the four years of trials, treatments with the higher dose of Cultar® showed higher flowering and production results. Fruit sizes were higher on the treatments when production was similar and similar when production was higher. los calibres de frutas fueron mayores a igualdad de kilos en los tratados y cuando la cantidad de kilos era muy superior, calibres similares al testigo.

Very high density (2,5 x 1,25m and 1,25 x 1,25m) plantings of avocados (*Persea americana* Mill.) Cv. Hass achieved over 40 t/ha in the first year of production

F. Gardiazabal, F. Mena, J. Torres, A. Pinto

GAMA, Quillota, Chile

Avocado growing areas in Chile are mostly located on hillsides. Traditional planting densities at 6 meters are difficult to prune and harvest, that has driven a change in the past 10 years in which there has been done an effort in reducing planting distances, having these days thousands of hectares of commercial orchards planted at 3x3 m and 2,5x2,5 m. In order to amortize the capital invested in new developments, trial at higher densities are being carried at distances such as 2,5x1,25 m and 1,25x1,25m. Nitrogen fertilization was tried in Orchards planted at 2,5x1,25 m and 1,25x1,25 m in spring and summer. Three different doses were tried in spring and three in spring + summer applications, plus the control without nitrogen. During the second year harvest, fruit size, flowering and the third year production were analyzed. The experiment was laid out as fully randomized and data were analyzed by ANOVA. Mean values were then compared by Tukeys test, with statistical differences tested at $P \leq 0.05$. Spring application of Nitrogen is the one that determines primarily the amount of harvest and the resulting flowering for the next year. Summer application is mostly related with final fruit size. Economic result shows that it is possible to payback all the initial investment and indirect and production costs with the first crop.

Changes in the avocado physiology and soil chemical characteristics in response to sulfuric acid and humic acid applied in clay soil

V. Celis¹, C. Bonomelli¹, B. Sallato¹, M. Fernández², P.M. Gil¹

¹ Facultad de Agronomía e Ingeniería Forestal, Pontificia Universidad Católica de Chile, Chile.

² Sociedad Comercial Asesora SA, Chile.

Autor para correspondencia: pmgil@uc.cl

Avocado is a sensitive crop to root asphyxiation, situation that reduces orchard productivity in clay soils. Among the agriculture managements adopted by farmers in Chile to improve soil aeration there is soil application of sulfuric acid at high concentrations. However, there is not information about how sulfuric acid affects local clay soils, and there is an increasing concern about the possible effects that frequent application of sulfuric acid might have on soil and plants. In the other hand, there are friendly alternatives to improve soil physical and chemical features, such as humic acids. An experiment in potted clonal Hass avocado plants established in clay soil was performed. Different soil treatments were applied to determine its effect on tree physiology and chemical characteristics in the soil. The treatments were, T0: only water; T1: H₂SO₄ (pH 2.5 once a month); T2: humic acid (3 cc/plant every 15 days); T3: H₂SO₄ + humic acid. Chemical soil parameters such as pH, EC, CEC, Na, Ca, Mg, Mn and Al were measured. The plant water status was also measured by stomatal conductance (gs) and stem water potential (SWP). Preliminary results indicate that T3 improved gs and SWP compared to the other treatments. In the other hand T1 reduced soil pH and increased availability of Al and Mn. T2 increased soil levels of Ca, Mg, Na and EC. In conclusion, the tested soil treatments can improve the physiological condition of avocados in soils of low aeration; however it is important to consider its chemical effect on the soil and thus the amounts and frequency of products application, because that is crucial if exceed the soil buffer capacity. Promptly, increased Mn and Al levels in the soil could affect plant development because it may cause plant toxicity; thus soil remediation management is important in that condition.

Homobrassinolide (Vitazyme®) and Paclobutrazol (Cultar®) for improving yield and to reduce alternate bearing in 'Hass' avocado

F. González-Valdés^{1,2}, L. Gurovich, J.A Alcalde¹

¹ Facultad de Agronomía e Ingeniería Forestal, Pontificia Universidad Católica de Chile, Santiago, Chile.

² Belloto Consultores Ltda. Quillota, Chile. Corresponding author. E-mail: fbgonzalez@uc.cl

In Chile, the average yield for 'Hass' avocado is rather low, partly due to an unbalanced distribution between vegetative and reproductive growth. Growth inhibitors such as paclobutrazol (PB) have contributed to increase productivity. Brassinosteroids, phytohormones like homobrassinolide (HBL), may affect the sink:source ratio. In order to evaluate the effects of HBL and PB on production, vegetative development and floral return, two experiments are established on a 'Hass' avocado orchard. Low flowering and high flowering trees were sprayed with con Vitazyme® (HBL: 22 mgL⁻¹) y Cultar® (PB: 250 mgL⁻¹): HBL-flowering (0.16 and 0.18 mgL⁻¹), HBL-flowering (0.16 and 0.18 mgL⁻¹) + PB-fruit-set (1000 mgL⁻¹), HBL-flowering (0.08 and 0.09 mgL⁻¹) + HBL-fruit-set (0.08 y 0.09 mgL⁻¹), PB-fruit-set (1000 mgL⁻¹). In the low flowering experiment, the foliar area increased (p=0.047), for applications of either HBL-flowering + PB-fruit-set and HBL-flowering + HBL-fruit-set. Also the treatment with HBL-flowering + HBL-fruit-set increased the ratio leaves:fruit (p=0.011) and consequently the intensity of floral return (p=0.028). In the high flowering experiment, the application of PB-fruit-set produced a foliar area larger than for HBL-flowering + HBL-fruit-set (p=0.04), nevertheless both treatments were not significantly different to the control, and the differences in floral return were not significant. Also, HBL-flowering, HBL-flowering + PB-fruit-set and PB-fruit-set increased fruit roundness, either for a high flowering year (p=0.0001) as well as for a low flowering year (p=0.0002). High production can diminish the vegetative development, floral return and diminish the leaves:fruit ratio, reducing the effect of PB and HBL over the fruit size.

■ Effect of crop load on tree yield and return bloom in New Zealand 'Hass' avocado orchards

N. Gould¹, G. Thorp², H. Boldingh³, E. Varkonyi-Gasic², P. West⁴, A. Vidiella⁴

¹. New Zealand Institute of Plant & Food Research Ltd, Te Puke, New Zealand

². New Zealand Institute of Plant & Food Research Ltd, Mt Albert, New Zealand.

³. New Zealand Institute of Plant & Food Research Ltd, Hamilton, New Zealand.

⁴. New Zealand Avocado Growers' Association, Tauranga, New Zealand

Alternate bearing is a key challenge to the New Zealand avocado industry, resulting in highly variable yields between seasons. Presented here is a research update from a five year programme lead by Plant and Food Research and New Zealand Avocado asking the question: can the effects of alternate bearing be reduced through manipulation of crop load? In this work we examine the timing of the genetic control of meristem differentiation, explore the effects of the presence of fruit on the regulation of transition from vegetative to floral meristems, study the impact of the timing of crop thinning on yield, shoot growth and return bloom and investigate the effects of fruit competition for resources on fruit growth. Progress towards the ultimate goal to provide crop regulation and management protocols to ensure sustainable, constantly high yielding avocado trees will be discussed.

■ Ecological and conventional cultivation of avocado. 13 Years of observations on adult trees

E. Guirado¹, J.M. Hermoso², J.M. Farré³

¹. Almuñécar. Granada. España

². IHSM-La Mayora-UMA-CSIC. Málaga. España

³. CIFA de Málaga. Málaga. España

Material and methods, statistical design and results of the first 5 years have been published: Hermoso *et al.* (2007).

We summarise here the observations in the same adult plantation, between 29 and 42 years of age, of Hass on Topa Topa. The ecological treatment received over this period 3 applications of almond shells (*Prunus amygdalus* B.) as mulching with no applications of synthetic fertilizers. Trees received 26 kg.m⁻² of dry almond shells under the canopy. Canopy cover was kept at 60 % by hedgerow pruning. The conventional control, without mulching, received yearly 50 – 60 kg.ha⁻¹ of mineral N.

Net yield (fruits picked from the tree), potential yield (fruits from the tree plus the ground) and tree efficiency (per unit trunk cross sectional area) were slightly higher for the ecological treatments in most years. Differences were statistically significant in one biennium and in the whole of the six bienniums of the experiment. Trunk girth growth and mean fruit weight were similar in both treatments. The 3 almond shell applications, with a separation of 5 years, decreased leaf lamina N contents significantly after the first application, non significantly after the second and nothing at all after the third.

The ecological treatment with massive applications of almond shells, rich in lignin and cellulose, for 13 years, strongly increased organic content in the top 25 cm of soil. As a result it was formed, under Mediterranean conditions, a soil profile similar to Mesoamerican *Persea* sp. forest soils. This clearly improved tree condition, even with N leaf levels slightly lower than the conventional system without organic matter applications.

PK nutrition of avocado. Conclusion of a 40 years experiment

E. Guirado¹, J.M. Hermoso², J.M. Farré³

¹. Almuñécar. Granada. España

². IHSM-La Mayora-UMA-CSIC. Málaga. España

³. CIFA de Málaga. Málaga. España

The experiment followed in the same trees, from 30 to 40 years of age, one of the studies included in Hermoso et al. (2003). In this second part of the experiment Zn, B and Cu were applied to all trees to prevent possible deficiencies. The design was on randomised blocks with 4 blocks and 4 trees per treatment and block. The treatments were P0 K0 (Control without P or K), P0 K1 (47.1 kg K₂O.ha⁻¹ año⁻¹) P1 K0 (47.5 kg P₂O₅.ha⁻¹.year⁻¹) and P1 K1 (P + K at the same doses). With the following mean leaf blade contents in the last 10 years:

P0 - .115 % P	K0 - .55 % K
P1 - .130 % P	K1 - .77 % K

No differences between treatments have been recorded in yield, tree efficiency or number of fruits. This supports the thesis, established by Hermoso et al. (2003) that potassium deficiency appears only when leaf K levels are held consistently below .5 %. We question therefore, for Hass avocados on Mexican rootstocks, recommendations to keep leaf levels above .7 %. High K levels could negatively affect the Ca/K relation in the fruit, increasing physiological problems or rotting especially at postharvest. The economic cost of the applications, as observed in this experiment, would be considerable. In a P poor soil, without applications during 40 years, leaf contents have kept stable.

Agricable – an empirical case for mechanised transportation of avocados on hillside plantations

R. Gurovich¹, A. Gurovich¹

¹. Agricable, Santiago, Chile

Investment in agricultural machinery is heavily dependent on the difficulties the producer faces to find effective workforce at a reasonable cost. Capital investment in mechanical equipment has traditionally focused on mobile and post-harvesting equipment, relying on manual labor for the picking, transportation and collection in the bin. The sharp increase of hillside plantation area has deepened the mechanization challenge. A 1976-publication of the California Avocado Society concluded that any solution to the problem of transporting the fruit from steep hillside avocado orchards should include “*modification of present type machinery, and/or development of new equipment*” (Gustafson, 1976). After four decades the problem persists. The project AGRICABLE, funded by the Chilean Economic Development Agency (CORFO), was originated in 2014 with the purpose of studying, designing, building and testing under actual field conditions, a mechanical transportation system aimed to become an effective and efficient solution to the fruit removal process from steep hillside avocado orchards. The field - tested prototypes and actual results obtained at the plantation of a large avocado producer between October 2014 and February 2015, demonstrate that the utilization of the AGRICABLE system increases labor productivity and is economically attractive for working hillsides slopes ranging from 20 to 45 degrees. Additionally, the results show that the equipment favors an increase of labor productivity in orchards characterized by low height and scarce fruit, to levels comparable to those obtained in similar orchards of low height and abundant fruit.

Loss of nitrogen using different platters of fertilizer (Loss of Nitrogen from different fertilizer sources)

E.F. Herández-Valdés¹, O.C. Ponce-García¹, A.C. Sánchez-Hurtado¹, A.K. Barragán-Martínez¹, R.E. Pérez-Sánchez¹, J. Esquivel –Córdoba, P.A. García-Saucedo¹

Universidad Michoacana de San Nicolás de Hidalgo. Uruapan, Michoacán, México.

Experiments in Michoacan, Mex performed with the objective of determining the nitrogen losses by leaching and volatilization. An assessment in an orchard of avocado under rainfed conditions, it was found that nitrogen reached 90 cm deep at 36 days after application with 490 mm of pluvial precipitation. In assessing nitrogen sources it found that calcium nitrate nitrates leached faster than other nitrates fertilizers (urea and slow release urea). It was determined that the urea was greater proportion of fertilizer nitrogen vaporized in contrast to slow release urea and calcium nitrate. In laboratory the applications of agricultural lime in combination with urea and ammonium sulfate stimulated volatilization losses.

■ Inflorescence architecture and fruit set in 'Hass' avocado

M.L. Alcaraz, [J.I. Hormaza](#)

Instituto de Hortofruticultura Subtropical y Mediterránea La Mayora (IHSM-CSIC-UMA). Algarrobo-Costa, Málaga, España

In plants in which flowers are grouped into an inflorescence, numerous studies have been carried out to investigate the relationship between reproductive success and position of the flower in the inflorescence. In order to determine the pattern of fruit set within compound inflorescences in avocado, different individual inflorescences were labeled, the diameter of primary, secondary and tertiary axes were measured at different levels and the initial number of flowers and final number of fruits were determined. Considering individual inflorescences, significant differences in the number of flowers were observed between determinate and indeterminate inflorescences although no differences were observed in fruit set percentage between individual inflorescences within the same compound inflorescence. Fruit set rate increased considerably in compound inflorescences in which vegetative growth was removed from each individual indeterminate inflorescence. A significant reduction in axis diameter was observed acropetally in the main, secondary and tertiary axes, whereas the highest number of fruits was observed at the most basal and apical regions in the individual inflorescences. The results obtained suggest allocation of resources among the individual inflorescence of the compound inflorescence and no clear effects of axis diameter on fruit set was observed. On the other hand, different opening patterns were observed among the three main kinds of flowers (terminal, king and lateral) within the inflorescence, although no differences were found on their capacity to set fruit neither in hand pollinated flowers nor in those left to open pollination.

■ Pollen limitation and fruit set in 'Hass' avocado

M.L. Alcaraz, [J.I. Hormaza](#)

Instituto de Hortofruticultura Subtropical y Mediterránea La Mayora (IHSM-CSIC-UMA). Algarrobo-Costa, Málaga, España

Pollination is a critical stage to assure fertilization and, therefore, fruit set in plants. Previous reports in avocado have shown that the percentage of flowers with pollen tubes reaching the ovary is affected by the number of pollen grains deposited on the stigma, although not all the flowers with fertilized ovules are able to set fruit. Our results showed that very few flowers reach a minimum of 20 pollen grains on their stigmas and that a high percentage of female flowers had received no pollen at the time of closing. The percentage of flowers with pollen on the stigma increased significantly after placing more beehives in the orchard suggesting that one of the limiting factors for avocado production under the environmental conditions of Southern Spain is a deficient pollen transfer to receptive stigmas. No significant relationship was found in the percentage of flowers with pollen on the stigma and the size of the inflorescence (number of flowers) but a positive relationship was found with male flower display. The attractiveness of the inflorescence to the honeybees is mainly due to the number of open flowers in the male stage that can allow the deposition of pollen on flowers in the female stage during the overlap between closing female and opening male flowers within the inflorescence. On the other hand, in spite that the probability that a flower developing into a fruit was significantly affected by the number of pollen grains adhered to the stigma, fertilization and subsequent fruit set can take place with a low number of pollen grains on the stigma.

■ To flower or not to flower? Exploring the effects of fruit load on floral induction in alternate bearing 'Hass' avocado trees

[V. Irihimovitch](#)¹, [D. Ziv](#)^{1,2}, [T. Zviran](#)¹, [O. Zezak](#)^{1,2}, [E. Eelson](#)¹, [A. Schaffer](#)¹, [A. Samach](#)².

¹. Institute of Plant Sciences, The Volcani Center, Agricultural Research Organization, Bet-Dagan 50250, Israel.

². The Robert H. Smith Institute of Plant Sciences and Genetics in Agriculture, Faculty of Agriculture, Food and Environment, The Hebrew University of Jerusalem, Rehovot, 76100, Israel.

In many fruit crop species, high fruit load inhibits vegetative growth and floral induction, resulting in a pattern of crop production known as alternate bearing. Here, we studied the effects of fruit-load on floral determination in 'Hass' avocado (*Persea americana*). De-fruited experiments first confirmed the negative effects of fruit-load on inflorescence development. Next, we isolated a *FLOWERING LOCUS T-like* gene, *PaFT*, hypothesized to act as a phloem-mobile florigen signal, and examined its expression profile in shoot tissues of on (fully loaded) and off (fruit-lacking) trees. Expression analyses revealed a strong peak in *PaFT* transcript levels in leaves of off trees from the end of October through November, followed by a return to initial levels. Furthermore and concomitant with inflorescence development, only off buds displayed up-regulation of the floral identity transcripts *PaAPI* and *PaLFY*, with significant variation being detected from October and November, respectively. In parallel, girdling treatments of on shoots, performed in early autumn, caused an increase in *PaFT* levels in leaves and resulted in subsequent flowering. Notably, both off and on+girdling leaves displayed considerably higher total soluble sugar (TSS) content, as compared with on leaves. Interestingly, in both cases, *PaFT* up-regulation correlated with increased accumulation of sucrose and perseitol, two phloem mobile transport sugars in avocado. However, from December, sugar levels remained high while *PaFT* levels decreased. Together, our data link *PaFT* with avocado flower induction and imply that fruit-load represses *PaFT* expression. The possibility that fruit-load might affect *PaFT* up-regulation by modulating leaf sugar levels will be discussed.

■ Fruit development alters the vegetative and reproductive shoot growth in 'Hass' avocado (*Persea americana*, Mill.)

R. Iturrieta¹, M. L. Arpaia¹, R. Heath¹, H. Smith^{1,2}

¹. Botany and Plant Sciences Department. University of California, Riverside.

². Commonwealth Scientific and Industrial Research Organization (CSIRO). Adelaide, Australia

In 2009, Dr. Wolstenholme proposed a hierarchy of factors involved in the horticultural problem of alternate bearing in avocado (*Persea americana*, Mill.). He gave a central stage to alternate bearing related genes but their identity is still an ongoing research effort.

Part of their elusiveness might be explained by the many different scales of observation of this phenomenon and we propose that a 'single shoot' is the most appropriate unit of observation at which research efforts can be focused. Not only is the minimum combination of fruit presence, vegetative and reproductive growth but also it can be followed at field conditions.

12 seven year's old 'Hass' avocado trees growing in at flatland were selected. 6 of them were enclosed by a bee excluding net during the bloom period. This technique completely avoided natural pollination and successfully excluded fruit presence.

There are observable divergent phenotypes at the single shoot level due to fruit presence. Most fruiting shoots will only carry a single fruit to maturity (80%) and have one single vegetative flush (70%).

Despite the previous, sunlight exposure modifies the observed vegetative and reproductive phenotypes and not only a redistribution to our data in relation to it was necessary but there was a clear realization that in order to more precisely dissect the effects of developing fruits on a fruiting shoot, sunlight exposure has to be considered.

■ Yield characteristics of 'Hass' avocado trees under California growing conditions

C. Lovatt¹, Y. Zheng¹, T. Khuong¹, S. Campisi-Pinto^{1,2}, D. Crowley², P. Rolshausen¹

¹. Department of Botany and Plant Sciences, University of California, Riverside, CA 92521-0124, USA

². Department of Environmental Sciences, University of California, Riverside, CA 92521, USA

Production characteristics of 'Hass' avocado trees in California were determined using yield data from ~3,000 trees in commercial coastal and inland valley orchards (33° 18' N, 116° 58' W to 35° 16' N, 120° 39' W) from 1992 to 2012. Over the 20 years, the majority of the trees produced at least 28 kg/tree (industry average), with 30% producing > 45 kg/tree and 16% producing > 90 kg/tree. As total yield increased to 190 kg/tree, yield of commercially valuable size fruit (178-325 g/fruit) increased to ~150 kg/tree; yield of small fruit (99-177 g/fruit) also increased, but remained a low percentage of the total. As yield increased above 190 kg/tree, yield of commercially valuable size fruit continued to increase, whereas yield of small fruit decreased. Less than 20% of the trees produced < 9 kg/tree; back-to-back yields < 9 kg/tree occurred in only 2% of the trees. Adverse climatic events causing the low yields initiated alternate bearing. For 66% of the trees, the alternate bearing index (ABI), a measure of the severity of alternate bearing, was 0.5 to 1 (50%-100% differences in yield between on- and off-crop years); 47% of these trees had an ABI between 0.75 and 1.0. To increase the yield of commercially valuable size fruit and net income, California 'Hass' avocado growers need to increase total yield per tree annually, which requires mitigating alternate bearing to reduce the occurrence of off-crop years.

■ Branch ringing as a technique for scheduling avocado harvests in tropical zones

D. Lynce-Duque¹

¹. Ingeniero Agrónomo Universidad de Caldas, Colombia. Asistente Técnico, Asesor y Consultor Particular de Cultivos de Aguacate. Investigador del grupo de investigación de Frutales Tropicales de la Universidad de Caldas. Trabajo en técnicas y manejo de cultivo, con énfasis en Podas, Fertilización, Asfixia radicular, Viveros, Técnicas de establecimiento y Manejo Integrado. davidlynce@gmail.com

Branch ringing in avocado production has been studied in subtropical zones principally as a method for increasing the volume of flowering and for improving fruit size. This paper shows how, under tropical conditions with trees that are in constant growth, this practice also permits harvest scheduling at any time in the year, by encouraging abundant determinate flowering in addition to normal flowering. In Colombia's tropical conditions, avocado trees produce two principal flowerings in a year. The first (December - February) provides for 60% of total production, and the second (June - August) provides another 30%, the remaining 10% of production is accounted for by a number of local flowerings throughout the year. The result is that production is concentrated in two time-blocks in the year (December-March and June-October) that coincide with the main production periods of other exporting countries. This study draws on over seven years of permanent field research conducted in commercial farms located in different productive zones within Colombia. The research includes experimentation with different techniques, tools, ring size and tree proportions, among other things, for the scheduling of harvests through ringing. The findings show that avocado trees flower 8-12 weeks after ringing at any time of the year. The ideal proportion of the canopy subjected to ringing (20-80% of the branches) depends upon the target market window. Farms that use adequate ringing techniques show 20% to 30% increases in crop productivity and receive 30% to 40% higher sales prices compared to their counterparts because they take advantage of market windows. The increase in tree productivity that results from ringing requires specific pruning techniques in order to maintain productive capacity in the long-term. Furthermore, under tropical conditions the ringing technique must be especially careful in order to avoid sanitary problems in the cuts that form the ring. Overall, a well-implemented ringing technique will not affect the development of the trees and allows for high-volume fruit harvests when market prices are high due to lower supply from other exporting countries in specific seasonal periods.

■ Agro-climatic suitability and identification of productive niches with low risk to water deficiencies for avocado in El Tambo, Colombia

L. Y. Deantonio¹, E. E. Martínez¹, E. Aguilera¹, G. Araujo¹, L. Ortiz¹, E. O. Rojas¹, F. Boshell²

¹. Corporación Colombiana de Investigación Agropecuaria, CORPOICA, Mosquera, Colombia.

². Asesor. Unidad de Agroclimatología. CORPOICA, Mosquera, Colombia.

Extreme weather events associated with climate variability ENSO (El Niño / Southern Oscillation) have caused significant economic losses Colombian agriculture. The identification of low exposure areas to agroclimatic threats becomes an important tool to planning agricultural land use and decreasing the vulnerability of crops to climate risks.

Identifying productive niches was made taking into account IPCC (2012) definition about agroclimatic risk based on crop exposure to climate hazards and crop sensitivity to water stress events. This analysis includes the FAO land evaluation methodology, water availability calculation using the PDSI index for the period 1980-2011 and a validation process with local stakeholders.

Analysis for growing Avocado (*Persea americana*) Hass and Choquette varieties in Fresno, Tolima, Colombia is presented. The modeling was performed taking into account the most sensitive phenological stages to water stress under normal weather, flooding and drought conditions, constructed from the characterization of climate variability in the area. It was found around 92000 ha with low agroclimatic risk to avocado under normal condition water. In flooding condition there are a significant reduction in potentially areas with lower agroclimatic risk to avocado (22800 a 57710 ha). Finally, under drought condition, there are about 49300 to 68370 ha with low agroclimatic risk for growing avocado. This work approaches to the study of climate risk to planning agricultural land use in the territory.

■ On-going study for selection and propagation of dwarf avocado plants showing remarkable homogeneity for commercial groves

R. Martínez Font ¹, R. Martínez Valero ², V. Guillermo Albitres ³, F. Ramirez Peña ³, J. Cortijo Biceral ³

¹. Profesor del Departamento de Producción Vegetal y Microbiología. Universidad Miguel Hernández Elche (Alicante. España).

². Profesor jubilado del Departamento de Producción Vegetal y Microbiología. Universidad Miguel Hernández Elche (Alicante. España) y actualmente colaborador contratado del mencionado Departamento.

³. Ingenieros Agrónomos de Agrícola Hoja Redonda. Chinchá (Ica. Perú).

Commercial avocado groves were monitored for four consecutive years looking for trees with outstanding reduced canopy volume. Those showing at least a twofold canopy reduction were obviously selected. They were also far higher yielders than the average ones. Furthermore, avocado fruit were checked as well to study their polyembryonic potential. Up to nine caulinar embryos were observed in some avocado seeds, which would allow to propagate dwarf yielding avocado plants with remarkable morphological and functional uniformity.

■ Effect of the application of *Ascophyllum nodosum* extracts on Hass avocado plants affected by sodium chloride

J. Mártiz ¹, J. Comejo ², P. M. Gil ¹, E. Ramírez ¹

¹. Facultad de Agronomía e Ingeniería Forestal. Pontificia Universidad Católica de Chile, Santiago, Chile

². Agroconsultores Limitada, Santiago, Chile

Avocado is a fruit tree species sensitive to salinity, accepting EC maximum levels of 0.75 mmhos/cm in water and 2 mmhos/cm in soil. In the central area of Chile most orchards are irrigated with water having critical levels of EC for avocado, which affects orchard productivity reaching averages of 7 Ton/ha. This is mainly because soil salinity affects plant water status, photosynthesis and growth. Biostimulant products based on algae extracts have shown good performance in reducing salt stress in various crops, but there is little information on fruit trees. Thus, we evaluated the effect of *Ascophyllum nodosum* extract (STIMPLEX[®]) on the development of Hass avocado plants irrigated with saline solution; the extract was applied through the irrigation water. One-year old potted avocado plants grafted in Mexicola seedling rootstock were used in this experiment carried out under greenhouse condition. Plants were irrigated with salt and *Ascophyllum nodosum* extract during 4 months as follows: T0 application of distilled water, T1 saline solution (5 mEq / l NaCl), T2 saline solution (5 mEq / l NaCl) + 3 ml Stimplex/plant, T3 saline solution (5 mEq / l NaCl) + 4.5 ml Stimplex/plant. The concentrations of saline solutions were doubled one month after the trial started and tripled at the third month. The number of leaves, CO₂ assimilation rate, chlorophyll index, biomass and leaf area at the beginning and end of the test were evaluated. Stomatal conductance (gs), quantum efficiency and stem water potential (SWP) were measured with weekly frequency. The application of *Ascophyllum nodosum* extract improved gs, photosynthetic capacity, chlorophyll content and leaf quantum efficiency; also it decreased abscission of leaves, increased leaf area and improved biomass measured as fresh and dry weight of leaves, stems and roots.

■ Effect of the application of product florone on production, size and dry matter in Hass avocado var.

M. Mattar Fajardo, M. Chavez

The effect of foliar application of Florone product was evaluated at different doses in production fruit sizes, and dry matter was determined. Hass adult trees grafted zrefreen 99 seed planted 7x5 mt with 10% pollinator.

A total of 40 trees per treatment distributed in random blocks was used. The commercial orchard located in the village Los Molinos department of Ica, Peru. The Florone treatments were T1 0.5%, T2 0.75%, T3 1%; T4 0.7% paclobutrazol + 0.3% compared to the control. The foliar application was made with de shoot over panicle outbreak about 5 to 10 cm of leng.

Regarding the sizes 8-14 Florone better result was 0.5% and the lower the number obtained paclobutrazol. Size 16 20 more units was 0.75% Florone and paclobutrazol, 22-26 and 28-32 caliber more units paclobutrazol and the control.

Relative to the dry matter the highest value is obtained with Florone 0.75% (24.5% ms), paclobutrazol (23.8% ms), Florone 0.5% (23.6 ms), Florone 0.75 % (22.9% more), control (23.4% more), the youngest to Florone 1% (22.5% more).

Number of fruits per tree the best value is obtained with paclobutrazol and Florone 1%, the lowest for Florone 0.5%.

Regarding production per hectare from highest to lowest: paclobutrazol 38 tm / ha, Florone 1% 34 tm / ha, 0.75% Florone 33 tm / ha, 0.5% and witness Florone

■ Effect of the application of product prosoil on nutritional analysis and leaf parameters in soil solution in Hass avocado (*Persea americana* Mill.)

M. Mattar Fajardo¹, C. Stark²

¹. Asesorías Pie del Mauco

². Empresa Green Universe Agriculture, S.L.

Within the productive factors in sandy soil conditions and climate of rain absence as the Peruvian coast, mineral nutrition is one of the management tools in farms to achieve production of medium to high level and sustained over time. Currently, technologies based on microorganisms applied to the soil improve the availability of nutrients and its absorption. It was analyzed the impact of applying the product Pro Soil (combination of *Trichoderma harzianum*, *Pseudomonas* spp. and *Bacillus* spp., humic acid, amino acids and yeast) on the level of nutrients in soil and leaf, in adult Hass avocado trees, in Santa Rosa area in the north of Lima, in the Peruvian coast.

Soil applications were in bloom, 30 days and 60 days after the first application. 10 trees were randomly selected for treatment, to which 4 soil samples were taken to each in order to obtain an homogeneous sample. Same methodology for foliar analysis.

Soil and foliar analyses were performed 15, 30 and 60 days after application. In harvest fruit number was quantified in both treatments. The results show that nutrient availability had increase at ground level.

Foliar analysis show that PROSOIL application does not increase the level of nutrients that are in highest concentration in the soil except for molybdenum. The number of fruits per treatment was higher by applying PROSOIL. CIC, organic matter and electrical conductivity increase in the soil by applying PRO SOIL.

■ Results in production, alternate bearing index, foliar chlorine level between of different west indian rootstocks compared with Topa Yopa in salinity crop conditions in the area of Ica, Peru

M. Mattar Fajardo, J. Bardalez, B. Quispe.

The information is presented since 2005 to the production obtained in Hass avocado orchard grafted onto different rootstocks (zrefreen 99, degania 189, najaloz, Ashdot, Topa Topa). At the same time the average production of the last six years of each rootstock with Hass well as alternating index indicated. The orchards are two, one is planted in February 2003 to a framework of 7x5 mts with 10% zutano pollinating. Drip irrigation. The second orchard planted in March 2008 at the same 7x5 mt. All lots are separated rootstock in commercial orchards of 6 hectares each, of the same age and the same technical management. The quality of irrigation water has electrical conductivity between 1 to 1.2 mS / cm and the chloride concentration is 3.8 meq / l.

Results

In both orchards there are differences in yields and index of alternating bearing, highlighting zrefreen 99 with high average yields of 25-30 t / ha every season and Topa Topa with under 16 ton / ha and higher rate of alternation. In the foliar analysis chlorides it became clear that the time of leaf analysis in March level corresponds with the result of 70-90 mm of fruit size, which zrefreen the value is 998.14 ppm, 1306 ppm Degania, Topa Topa 3984 ppm, Ashdot 396 ppm. The index corresponds to 0.06 alternating najaloz, zrefreen99 0.01, degania 0.15, 0.24 Topa Topa.

■ Effect of the number of Edranol pollinators over the avocado (*Persea americana* Mill.) Cv. Hass productivity

E. Mena, F. Gardiazabal, J. Torres, A. Pinto

GAMA, Quillota, Chile

The need for pollinizers to obtain higher crops on Hass avocados has been proved in different countries. In a trial carried at PUCV several years ago in Quillota it was demonstrated that male parental of Hass fruit form plots with different pollinizers corresponded mostly to the pollinizer that was inside each plot. One way to isolate the trees from the rest of the orchard condition was to put a net on a group of trees in order to evaluate the effect of different percentage of pollinizers. The trial was carried in a Hass Avocado orchard with 5,5% of Edranol as Pollinizer, planted at 3x3 m. Statistical design was completely randomized Blocks. Treatments were:

T0: No nets, 5,5% pollinizer under nets the following treatments: T1: 12 Hass and 0 Edranol; T2: 11 Hass and 1 Edranol and T3: 10 Hass and 2 Edranol. Flowering, tree crop and fruit size were evaluated.

Flowering, crop and fruit sizes differed year to year, but results clearly show that the treatment without pollinizer is the one that obtains the worst crop. Additionally the treatments with pollinizer, despite of having higher crops showed better fruit size.

■ Group behavior of 200 avocado trees (*Persea americana* Mill.) Cv Hass grown in Panquehue, Chile

E. Mena, F. Gardiazabal, J. Torres, A. Pinto

GAMA, Quillota, Chile

There is a high variability in growth habit, flowering, production, fruit size and others, among a population of Hass avocado trees grafted on Mexicola seedling rootstocks. With the objective of determining this diversity and find highly productive trees, with low alternate bearing, productive parameters were recorded for 4 years in a population of 200 trees planted at 3x3 m.

The trial was carried on Hass avocado trees grafted on Mexicola seedling rootstock during four years in the Panquehue area. Selected trees were evaluated for trunk perimeter, tree size, flowering and production, fruit size in a sample of fruits. The best 20 trees were selected and evaluated for leaf and starch content analysis.

Crop per tree was highly influenced by alternate bearing, over 70% of the trees showed alternate bearing showed Alternate Bearing Index (ABI) higher than 0,7. Annually produced kilos depended on whether the trees were on the “on” or “off” year. The 20 highest yielding trees were selected, in the 4 year average they produced more than 4 times the yield produced by the 20 worst yielding trees and produced over 80% higher than the average of the complete population.

■ Harvest period effect on productivity and fruit size of avocados (*Persea americana* Mill.) Cv. Hass

E. Mena¹, M. L. Arpaia², R. Hofshi³, F. Gardiazabal¹, A. Pinto¹, J. Torres¹

¹. GAMA

². U. California Riverside

³. Hofshi Foundation, Chile, USA.

On the hillsides of the central area of Chile, the Hass variety is generally over 23% Dry Matter content in August, nevertheless many growers delay the harvest based on different reasons (commercial, pickers availability, etc). This means a delay in 4 to 5 months after reaching minimum maturity, affecting tree crop for the incoming years. During 4 years, harvest was done in different months, to determine the best harvest dates based on production parameters such as flowering, tree crop and fruit size. The trial was carried on Hass avocado trees grafted on Mexicola seedling rootstock during four years in the Panquehue area. Treatments were the following: total fruit harvested in August, September, October, November, December and January, also two passes harvest was carried in August and September, August and October, October and November, October and December. The experiment was laid out as fully randomized with 10 treatments and 15 replicates by treatment. Data were analyzed by ANOVA. Mean values were then compared by Tukey's test, with statistical differences tested at $P \leq 0.05$. In the first year, the later the harvest the higher the crop and fruit size, something that drastically changed in the later years, being the total tree crop lower in January and August for completely different reasons.

■ Spray application of Paclobutrazol and potassium nitrate during flowering, reduce new shoot vigour and increase cropping of “Mendez” avocado

S.A. Oosthuysen¹, M. Berrios²

¹. HortResearch SA, P.O. Box 3849, Tzaneen, South Africa

². SQM Mexico, Lote 30 Manzana A, Parque Industrial Buganbilias, Tlajamulco de Zuniga, Jalisco, Mexico

Bearing Mendez avocado trees were sprayed with paclobutrazol or paclobutrazol (Austar at 1 or 2%) plus KNO₃ (2% w/v) when the inflorescences were developing and flowering. In addition, soil applications of paclobutrazol were made (3 or 6 ml Austar applied around the trunk). The general effect of paclobutrazol plus KNO₃ treatment was to reduce the vigour of the new shoots arising after flowering (final length from 35 to 23 cm, or 33%), and to increase fruit size (120 to 175 g, or 46%). Fruit number was not reduced, and hence yield was increased. No additional cropping benefit or reduction in shoot vigour occurred as a result of the added application of paclobutrazol to the soil around the tree trunks. The specific effect of the addition of 2% (w/v) KNO₃ to paclobutrazol in spraying, was an increase in number of fruits retained until harvest (0.57 to 0.75 fruits per inflorescence, or 32%). No effect relating specifically to the difference in the rate of paclobutrazol applied to the soil was observed. Our research indicates a marked benefit to spray applying KNO₃ with growth retardants during flowering to increase tree yield.

■ Integrated research to deliver sustainable benefits to small-holder avocado farmers in Kenya

G. Thorp¹, B. Clothier², A. Woolf³, B. Fullerton³, J. Campbell⁴, M. Gitahi⁵, M. Chepkemoi⁵, E. Périé⁶

The New Zealand Institute for Plant & Food Research Limited (Plant & Food Research): ¹Australia, ²Palmerston North, ³Auckland, ⁴Motueka, Kenya, ⁵Olivado Kenya (EPZ) LTD, Murang'a area, ⁶Te Puke

A new five-year programme has been established in Kenya to support the avocado sector by enhancing sustainable horticultural production and postharvest systems, thereby increasing the capability and income (and the security of that income) of small-holder farmers. The development is being funded by the New Zealand Aid Programme and is being implemented by The New Zealand Institute for Plant & Food Research Limited in partnership with the avocado oil company Olivado (New Zealand). The work is being undertaken in-territory with local farmers and horticultural research/extension organisations.

The programme is focused on improving the incomes of small-holder avocado producers by increasing the yields and fruit quality of avocados for the production of high quality food-grade oil based on the principles of fair trade and organic production systems. The project has identified five key activities: the rejuvenation of existing orchards with planting of new trees and the remedial pruning of existing "large" trees, soil and water management, tree nutrition and plant health, development of decision support tools for growers and postharvest systems for oil yield and quality. Through investment of funds and expertise, this new programme provides an opportunity to utilise New Zealand's internationally recognised expertise and leadership in agritechology to make a significant niche impact on Kenya horticulture. This paper will provide a review of the challenges, progress and achievements from these activities to illustrate the benefits of taking a whole-system's approach to development programmes.

■ Quantification of ammonia losses under controlled environment in soil taken from the Uruapan Michoacan avocado producing región

O.C. Ponce-García¹, A.C. Sánchez-Hurtado¹, R.E. Pérez-Sánchez, P.A. García-Saucedo, E.F. Hernández-Valdés¹

¹. Facultad de Agrobiología "Presidente Juárez". Universidad Michoacana de San Nicolás de Hidalgo. Uruapan, Michoacán. México.

On the ground, there are different ways in which the nitrogen can be lost, highlighting leaching, volatilization and denitrification lesser extent. One way less studied in Michoacan Avocado producing region is volatilization, therefore the objective of this study was to evaluate the amount of nitrogen lost through ammonia volatilization in soil taken from the Uruapan Michoacan avocado producing region. The experiment was conducted in the soil laboratory of Faculty Agrobiology "Presidente Juárez" from Uruapan, Michoacan and implemented a completely randomized design with four treatments (Urea, Slow Release Urea Ammonium Sulfate and Control) with three replicates. The results showed that the Urea was greater volatilization treatment (13.2%) followed by Slow Release Urea (2.08%) and Ammonium Sulfate (0.27%) showed poor results volatilization.

■ Implementation of electrostatic application system for helicopters in avocado

D. Redon Solís¹, N. Tironi Gallardo², R. Andrade Niklitschek³, R. Herrera Cid⁴

¹. Tivar helicópteros SPA. Quillota, Chile.

². Tivar helicópteros SPA. Quillota, Chile.

³. Facultad de Agronomía. Universidad de Chile, Chile.

⁴. Facultad de Agronomía, Universidad de Chile, Chile.

Today, Chile has over 36,000 avocado planted hectares, most of them on hillsides with high density frameworks, this situation has made traditional spraying very inefficient in terms of coverage and the adequate times recommended for the product. On this scenario, a few years ago, producers started using airplanes and helicopters to improve the efficiency of their fumigations. Aerial spraying is considerably faster than ground spraying, but it is more demanding on environment conditions, since the process must achieve that the small drops from the nozzle system really hit their target without losing them due to evaporation, wind drift and/or the vortex effect.

A Project was carried out in order to improve the quality of the aerial sprayings by implementing a new technology for crop dusting with helicopters, based on the use of electrostatic technology to achieve a higher spraying efficiency and reduce its costs. The system effectiveness tests were performed on commercial avocado orchard located on the 5th region, and the difference on effective coverage in terms of coating and product deposit for both, conventional and electrostatic system. A set of trees was selected and marked with water sensitive paper, at different heights and depths within the trees and later analysed by software.

Statistical differences were observed between the electrostatic and the conventional spraying systems for helicopters when tested on avocado trees, being the electrostatic system 60% more efficient on fumigation coverage and 55% on drop distribution.

■ Hass avocado phenology, a tool for planning it's cultivation in the state of Mexico

J.C. Reyes-Alemán¹, O.R. Montiel-Rodríguez¹, E. Urbina-Sánchez¹, S. Aguilar-Medel¹, J. Mejía-Carranza¹, M. C. Espíndola-Barquera².

¹. Centro Universitario Tenancingo, Universidad Autónoma del Estado de México. México.

². Fundación Salvador Sánchez Colín, CICTAMEX S.C. México.

The generation of an avocado technology package is based on the knowledge of the biological plant phenology. In the State of Mexico it have been described tree mainly specific environments for the cultivation of the avocado: the cold, the humid temperate and the warm humid with summer rains weathers. The three conditions produce some different morphological and physiological responses on the cultivar Hass development. In this first approach work, the step number one consisted on generate knowledge about phenological phases, the second part on generate a package of technological recommendations to improve crop response including fertilizers, phytosanitary management, irrigation, according to the conditions climate and kind of soil of the regions. Is exhibited the different phenological responses of the cultivar, its intensity, duration and interaction of each phase in the three environments. Is important the phenology phases shift, so the effects observed are detailed on the root growth, vegetative growth, flowering, fruit set and fruit growth, a phenology model for each region is suggested and a technology package is developed.

■ Who actually close the avocado stomata during a daytime?

A. Silber^{1,2}, M. Noy³, A. Naor^{1,4}, S. Assouline²

Key de entrada: P6H3SNA4G

¹. Northern R&D, Israel, P.O. Box 9000, Rosh Pina 12100, Israel

². Institute of Soil, Water and Environmental Sciences, Agriculture Research Organization, the Volcani Center, P.O. Box 6, Bet Dagan, Israel.

³. Shaham, Extension Service, Ministry of Agriculture, P.O. Box 28, Bet Dagan 50250, Israel

⁴. The Golan Research Institute, P.O. Box 97, Kazrin 12900, Israel

The objective was to investigate the combined effect of irrigation regime and fruit load on the development 'Hass' avocado trees grown in lysimeters, at different phenological periods. The effects of the fruit sink on water uptake and gas-exchange properties were assessed by comparing the performance of fruiting and defruited avocado trees.

The role of leaf-carbohydrate concentrations was emphasized by fruit removal. Fruit presence provided a significant sink for carbohydrates, which vanished when they were removed. Rapid accumulation of carbohydrates in leaves of defruited trees induced a reduction in stomatal aperture early in the morning, which led to reductions in stomatal conductance (g_s) and photosynthesis per unit leaf area (A) rates in the course of the day, in spite of the increasing irradiance and vapor pressure deficit (VPD). The strong carbohydrates sink formed by the presence of the fruits slowed down carbohydrates accumulation, enabling additional factors, such as irradiance, VPD, and root-zone water regime to affect g_s and A . Higher stomatal aperture in fruiting tree induced a significant increase in water uptake of compared with defruited trees and consequently, their daily water uptake was 40% higher than that of defruited trees, thus despite the higher vegetative growth of defruited trees. The traditional 'KCET0' approach might be insufficient as a basis for proper irrigation management during the productive period and irrigation management should be adjusted therefore for the actual crop load.

■ Fertilizer needs for Maluma - a case study

B. Snijder¹, A. A. Ernst²

¹. Afrupro Exporters, P.O.Box 158, Tzaneen, South Africa

². A H Ernst & Seuns, P.O.Box 91, Tzaneen, South Africa

Maluma is a young cultivar originating in South Africa. It has been cultivated for the past 8 years commercially and export volumes to the EU are increasing rapidly as more hectares are being planted. The cultivar expresses good yields with larger sizes than the standard Hass making this cultivar in certain areas in South Africa more profitable than Hass. As is the case with most new cultivars cultivation practises are initially based on closer relatives, but as the cultivar grows, more specific practises are need to be defined. This is certainly the case for Maluma as it is higher yielding than Hass with larger fruit and an earlier harvest slot than Hass. This created some interesting challenges recently.

In this study we tried to understand something about the fertilizer needs of Maluma in relation to yield parameters. Climatic considerations were currently not included. The study is a case study on three commercial farms with 10 – 11 year old trees. Leaf and soil analysis were compared to yield factors over the last 5 years. Some interesting observations were made in this study, but the authors had to conclude that more structured research is needed to understand the behaviour of this cultivar better.

■ The relationship between the farmer, researcher and the extension advisor

W. Stones

Aguacate Productores de la Asociación de Sudáfrica (SAAGA / Subtrop), Tzaneen, Provincia de Limpopo, Sudáfrica

The philosophy of extension is to: “Help farmers to help themselves”. Extension approaches have evolved from linear to advisory models, which focused mainly on transfer of technology with limited interaction between role players. Modern extension approaches include facilitation and participatory models that encourage interaction amongst all role players. Previously the South African Avocado Growers Association’s (SAAGA) extension advisors served their members according to an advisory extension approach. During 2006, the Subtrop amalgamation took place, which is an umbrella organization that manages the affairs of SAAGA, SAMAC (SA Macadamia Growers Association), SAMGA (SA Mango Growers Association) and SALGA (SA Litchi Growers Association). After the Subtrop amalgamation a farmer satisfaction survey on extension services and the research coordination function of Subtrop, was conducted in 2010 with Subtrop members. A structured questionnaire was developed with open and closed questions using Likert-Type scale response anchors. Survey participants had to indicate their perception and utilization of the following main extension services: farm visits, newsletters, study groups and relevant websites. What avocado farmers expected from extension advisors, the relevance of advisors as well as the interaction and role of and between extension advisors, researchers and farmers was investigated. Suggestions to improve extension services are suggested and the role of the farmer in the research environment is highlighted.

■ Benefits of solubilizing microorganisms in recovering and maintenance of agricultural soils

A.Velázquez-Gurrola¹, M.P. Ramos-Alegría¹

¹. Applied Biotechnology South America, S.A. de C.V. Chiapas, México. armenia@abiosamexico.com

In modern agriculture is common to apply high levels of mineral fertilizers and other agricultural chemicals, in order to increase production and cover the growing demand for food. Although the use of these inputs presents immediate benefits on the performance of the crops, it is well known that its use can adversely affect the quality and productivity of agricultural soils. Due to this situation, the use of beneficial microorganisms has gained in importance as an alternative to the chemical fertilization and have been isolated strains of bacteria (*Pseudomonas fluorescens*) and fungi able to solubilize phosphorus (*Paecilomyces lilacinus*), mobilize potassium (*Trichoderma harzianum*) and sulfur (*Bacillus* sp), in addition to the already known nitrogen fixing bacteria (*Azospirillum brasilenses*). The plant-microorganism symbiosis can reduce soil degradation and optimize the return of energy to the production systems. The increase in the productivity based on large quantities of energy cannot be maintained indefinitely. There is a limit on the production capacity and is governed by the external costs of energy that are entered in agroecosystems, and soil microbiology figure as a key part, especially in those degraded soils and intensive production systems.

■ Productivity research in NZ, moving towards a collaborative learning environment

A. Vidiella, P. West, D. Vanderheijden¹

¹ New Zealand Avocado Growers' Association, Tauranga, New Zealand

A comprehensive R&D programme has been developed by NZ Avocado in the last two years. The programme is aligned to the industry strategy and is aimed to optimize the productivity of our orchards to meet customer needs. The programme has a holistic approach to productivity, intending to identify and understand the main factors that limit productivity in our main production areas. Understanding that integrating scientific and local knowledge in this process is highly desirable and notoriously difficult to achieve, the programme is based on coproduction principles, with a significant portion of stakeholders involved in the development of the programme during all of its stages. This approach is having a significant impact on the programme, mainly directing it in the right direction, increasing its effectiveness, and developing, sharing and implementing new knowledge from the onset of the programme. Following a preliminary analysis of the factors that seem to affect productivity in NZ, the factors were prioritized considering the impact that addressing them would have on productivity. This led to a plan that has allowed the programme to increase the investment in R&D in avocados in New Zealand four times in the last two years, with the consequent increase in capability, with Plant & Food Research being instrumental in this process.

■ Reproductive ecology of avocado and its impact on fruit production

L. Villamil¹, Y. Merlin², M. Gavito², M. Devoto³, R. Ayala⁴, E. Ramírez⁴, M. Astier⁵

¹ Corporación Universitaria Santa Rosa de Cabal, Unisarc. Santa Rosa de Cabal, Colombia

² Centro de Investigaciones en Ecosistemas, Universidad Nacional Autónoma de México, México

³ Cátedra de Botánica, Facultad de Agronomía, Universidad de Buenos Aires, Argentina

⁴ Instituto de Biología, Universidad Nacional Autónoma de México, México

⁵ Centro de Investigaciones en Geografía Ambiental, Universidad Nacional Autónoma de México, México

The avocado (*Persea americana* Mill.) is a tropical native species from Central America, that opens its flowers in masculine or feminine stages at different hours of the day, a phenomenon that promotes pollination mediated by insects. This work evaluated the specific diversity of floral visitors and pollen carriers in conventional and organic avocado orchards, the importance of each insect species in the transportation of pollen and the contribution of floral visitors to total fruit production. The study was conducted during two consecutive years during the peak of blooming 2010/11 and 2011/12, in 4 conventional and 6 organic orchards. Four orders, 22 families, 58 species and 12 morphotypes were identified, from which 39 species were confirmed as pollen avocado carriers. Several native insects, including flies, wasps and bees, carried large amounts of avocado pollen. However, the introduced European bee was by far the most abundant flower visitor. Fruit production was determined by the presence of floral visitors ($U = 41,000$; $p = 0.001$). The trees in exclusion presented 28.3 ± 10.05 in contrast trees without exclusion with 118.0 ± 22.70. Results suggest that orchard management may affect the diversity of the insect fauna and have an impact on orchard productivity, through pollination and fruit production.

■ Pruning flowers and fruit to reduce alternate bearing in New Zealand

A. Vidiella¹, P. West¹, N. Gould², G. Thorpe², A. Barnett²

¹ New Zealand Avocado Growers' Association, Tauranga, New Zealand

² The New Zealand Institute for Plant & Food Research Limited, Tc Puke, New Zealand

Pruning is one of the most important tools we have to balance avocados. Pruning to balance trees has been carried out for many years in several orchards in New Zealand with success in many instances. Of the different strategies followed in our orchards, there is a significant degree of consensus that structural pruning done in autumn followed by flower pruning before flowering seems to yield the best results. However, this is based on anecdotal information. NZ Avocado and Plant & Food Research are starting the third year of a five year trial aimed to increase our knowledge of the usefulness of pruning to balance trees. This paper reports the results obtained in the trial carried out the first year of the project.

The first year of the trial focused on removing fruit shortly after fruit set from trees that were clearly overloaded, following a very heavy flowering on an off production year. The pruning consisted in removing 30 to 50% of the fruit of the trees by pruning. Thirty trees were pruned in late December, thirty in early February, and 30 trees were left unpruned. The experiment was designed in randomized blocks with single tree plots. All trees were in a 3 ha block of a commercial orchard near Katikati, Bay of Plenty. Removing the fruit in December increased the density of the canopy, had no impact on yield and led to an increase in the size of the fruit.

■ Crop of organic Hass avocado in the Peruvian coast

K. Bederski¹, J. Limascca¹

¹. Vivero Topara, AgroExport Topara, Fundo El Lucumo, Topara Chinchá - Perú

The first Hass avocado fields certified organic conducted within parameters were planted by the main author in the early 2000s under conditions characteristic of arid soils and subtropical climate of the central coast of Peru. The technical feasibility of producing organic avocado with higher economic benefit was demonstrated from the outset and has led to a continuous increase in export customs records of this specialty gourmet. The agronomic principles regarding the plant-soil-water management and especially as they relate to controlling risks are similar for both avocado crops that are driven by conventional methods as those conducted with organic technology. So it is with the principles relating to phytosanitary management, herbs and pruning. This paper shows the different way in which these common agronomic principles are all managed within organic parameters. Without limitation, the root growth of avocado plants - dampening factor entire floor area that wants to be explored is emphasized. Analysis of complete characterization of soils under the canopy where roots and in the center of the ridge where there are not shown. Also, analysis of the nutritional status of the foliage along the annual phenological cycle. The difficulty factor phytosanitary prevention by implementing specific monitoring systems is emphasized. Economic data are presented in terms of the cost to the producer per kilogram of avocado that you accept packaging factories for export. Furthermore, statistics issued by SUNAT-Customs.

■ Investigations into factors limiting pollination of avocado (*Persea americana*) in New Zealand

D. E. Pattermore¹, H.M. McBrydie¹, B.T. Cutting¹, R.M. Goodwin¹, B. Howlett², L.J. Evans¹, H. Boldingh¹

¹. The New Zealand Institute of Plant & Food Research Ltd, Hamilton, New Zealand

². The New Zealand Institute of Plant & Food Research Ltd, Lincoln, New Zealand

To investigate whether poor pollination contributes to irregular bearing and low yields in New Zealand avocado orchards, we assessed the relative contribution of different pollinator species, the importance of pollenisers, and the effect of cold temperatures on flowering and pollination. Pollen deposition on stigmas from single pollinator visits differed significantly between species, ranging from a mean of 0.125 pollen grains/visit for Black hover flies (*Melangyna novaezelandiae*), to 1.5 pollen grains/visit for honey bees (*Apis mellifera*), and 6 pollen grains/visit for march flies (*Dilophus nigrostigma*). Flies and honeybees had significantly less avocado pollen on their bodies when caught off female stage 'Hass' flowers than when caught off male stage 'Bacon' flowers. In contrast, bumblebees (*Bombus terrestris*) carried equal amounts of pollen when caught off either female 'Hass' or male 'Bacon' flowers, thus indicating greater cross pollination potential. Yields declined with increasing distance from pollenisers in some years, and distance to polleniser had an overall significant negative effect on mean annual yields. Using time-lapse cameras, we discovered that female 'Hass' flowers stay open all night following previous overnight temperatures of 6°C or below. Numerous fly, moth and beetle species visit avocado flowers at night and we have recorded these insects carrying avocado pollen. Fruit set rates are not consistent throughout the flowering season and fruit set can occur during colder periods when overnight temperatures are less than 11°C. By matching the optimum times for pollination with the activity patterns of effective pollinators, we aim to enable growers to optimise their pollination.

■ Foliar protectors for reducing winter water stress in tropical avocados grown under rainfed conditions

S. F. Angolini, T. Cantuarias-Avilés, S.R. Da Silva, L.I. Cagale, B.A. Brogio

Universidade de São Paulo, Piracicaba, São Paulo, Brasil.

Rain-fed avocado production in Brazil is characterized by irregular rainfall distribution along the year that imposes severe periods of winter drought during important phenological stages, thus limiting tree growth, fruit yield and quality in this species. This work was aimed to evaluate the effects of applications of different foliar protectors for reducing winter water stress in a commercial orchard of tropical 'Breda' avocados grown under rain-fed conditions in the southeastern region of São Paulo State, in Brazil (23°12'S, 49°27'W, altitude 560 m). The following treatments were sprayed during the drought period (May till August 2014): (T1) water; (T2) 1% bi-distilled glycerin; (T3) 1% mineral oil; (T4) solution with 80% kaolin (hydrated aluminum silicate) + 25 g 100 L⁻¹ chelated zinc (14% EDTA Zn) + 0,05% potassium silicate + 0,075% Silwet L-77 spray adjuvant; (T5) solution with 70% calcium carbonate (Nublado®); (T6) solution with 95% kaolin (Protecsol®). Leaf water potential, color, abscission rate, chlorophyll content and fruit quality were assessed. From pre-flowering until fruit set, the trees sprayed with T5 kept better water status, followed by those sprayed with glycerin (T2) and mineral oil (T3). Application of T4, T5 and T6 did not affect foliar abscission rate. During flowering, leaves of trees sprayed with T6 kept a darker color. No significant differences were observed between treatments regarding the remaining measured variables. The use of foliar protectors comes out as an interesting alternative for reducing water stress of 'Breda' avocados grown in rain-fed conditions, thus contributing for maintain canopy water status.

Productive and physiological responses of 'Hass' and 'Quintal' avocados grown with and without supplementary irrigation in São Paulo state, Brazil

T. Cantuarias-Avilés, S.R. Da Silva, S.F. Angolini, L.I. Cagale, B.A. Brogio

Universidad de São Paulo, Piracicaba, São Paulo, Brasil.

In Brazil avocados are mainly grown under rain-fed conditions, and they are exposed to drought periods during the winter, which impose a severe water stress to the trees during important phenological periods such as flowering and fruit set, thus limiting their potential yield. Consequently, this work aimed to quantify the effects of supplementary irrigation applied in the winter period over tree growth, water status, fruit yield and quality of 'Hass' and 'Quintal' avocados, planted in 2010 in two commercial orchards in the southeastern region of Sao Paulo State (23°07'S, 49°30'W, 695 m altitude). Three treatments were compared: (i) no irrigation during the dry period; (ii) irrigation with a total water sheet of 647 mm, as defined by local farmers; (iii) complementary irrigation with half of this water sheet (323 mm). During the first year, the application of the largest amount of water kept soil moisture in an adequate level up to 40 cm depth, in both cultivars. Nonetheless, the application of both irrigation sheets in the 'Hass' cultivar was insufficient to keep soil moisture up to 80 cm depth. In both cultivars, supplementary irrigation applied during the first year of the trial increased tree size and water use efficiency and improved plant water status, although it had no significant effect over fruit yield and quality. The results of the first year of the trial indicate that supplementary irrigation during winter dry period improves plant water status and water use efficiency both in 'Hass' and 'Quintal' avocados.

Ageing study of avocado (*Persea americana*) cv. 'Hass' in the temperate valleys of Jujuy, Argentina

V. Curzel^{1,2}, A. Zelaya¹, S. Buono^{1,2}, D. Aramayo¹

¹. Facultad de Ciencias Agrarias. UNJu. Jujuy. Argentina

². INTA (Instituto Nacional de Tecnología Agropecuaria)

In Argentina, the production of avocados is a relatively new activity, local research is scarce, there is not systematic information on the behavior of growth cycles. During the period 2012-2014 he worked in a commercial avocado plantation located in the temperate valleys of Jujuy. Ten plants of uniform size and general condition were selected, identified and marked 10 outbreaks of each flow for each cardinal point vegetative growth. Outbreaks of spring, summer and autumn were identified. Post-fruit set outbreaks marked BDSF (determined without fruit bud), BDCF (given outbreak fruit), BISF (undetermined outbreak without fruit), BICF (undetermined outbreak fruit) were classified. They were conducted monthly soil sampling to determine the presence of new roots. summer autumn (March) Spring (September), (December-January) and; three vegetative flows were determined in 2012 and 2013 and two vegetative flushes in the 2014 spring and summer. Only a floral flow (September) occurs. The spring and autumn flows showed less intensity and duration that the flow of summer. The growing flow Autumn is casual, it appears in years of low productivity. Regarding the productive efficiency of outbreaks, of all outbreaks marked (400 in spring and 400 in summer), 42.5% had fruits and the highest percentage of shoots with fruit was recorded during the flow of summer growth (53%). Of this, 62.7% was for BD. Spring sprouts, 80% of those with BD were also fruits. two peaks of production of young roots were recorded in the late winter (August) before the growing flow of spring and the second in the summer, coinciding with the rainy season, peaking in February. Then root production gradually decreases to be minimal during July.

Efficient use of water for growing under conditions of Hass avocado Colombian tropics

D. Dorado Guerra¹, L. Grajales Guzman¹, A. Rebolledo Roa¹

¹. Centro de Investigación Palmira, Corporación Colombiana de Investigación Agropecuaria (Corpoica). Palmira, Valle del Cauca, Colombia.

Cash crops in Colombia Hass avocado, do not handle technical criteria for irrigation application. In order to define the water level to be applied in crop production stage, for two consecutive years, three irrigation levels were evaluated in a commercial Hass avocado (*Persea americana*) orchard grafted on criollo (probably of West Indian origin) rootstocks grown from seed. The treatments were based on three levels of irrigation levels based on reference evapotranspiration (ET₀): L1 = 0.5, L2 = L3 = 0.75 and 1.0. ET₀ was determined with FAO Penman-Monteith and calculation of irrigation depth was performed using water balance. Fruit growth and production efficiency of the water was analyzed. In the initial stage of the fruit filling, no differences were observed coinciding with a positive water balance. In the final phase of fruit growth, coinciding with a period of drought in 95 days, fruit diameter was greater with L1 and L2 compared to L3, and yields of 16.9 and 19.2 ton/ha were obtained respectively. 57.5, 74.8 and 116.9 m³/ha were applied per production cycle corresponding to L1, L2 and L3 respectively, meaning water savings of 49% for L1 and 36% for L2. The best water irrigation efficiency (WIE) was obtained with L1 with a value of 294.4 kg/ha /m³ followed by L2 with a value of 256.4 kg/ha/m³. Furthermore, L1 and L3 had similar yields, although the rate of water efficiency was greater for L1, indicating that applying greater water irrigation levels does not guarantee an increase in production and on the contrary it can elevate production costs and result in overexploitation of the resources.

■ Increasing fruit size of 'Hass' avocado (*Persea americana* Mill.) using gibberellic acid, thidiazuron and girdling

S. Flores Vivar¹ J. Escobedo Alvarez¹

¹. Universidad Nacional Agraria La Molina. Lima, Perú

In three trials, the effect on fruit size from different doses of gibberellic acid (GA): 25 and 50 ppm, three doses of thidiazuron (TDZ): 25, 50 and 100 ppm, and two different timing of branch girdling: full bloom and 60 days after full bloom (dafb), was studied on adult avocado trees. Plant growing regulators (PGR) were applied 60 dafb, when the fruits were 30 mm on diameter, approximately. In all treatments, assessments were carried out 3 weeks before harvest. GA application did increase the diameter and length of fruits in 3.4 and 3.2 mm, but without significant differences compared to the treatment. On TDZ treatments, only 25 and 50 ppm doses showed significantly larger diameters: 60.1 and 61.0 mm, compared to the control (55.6 mm). However, length was increased with the three TDZ treatments: 86.6, 88.6 and 85.9, respectively, compared to the control: 79.9 mm. Girdling on full bloom did not have any effect, nevertheless, on branches girdled 60 dafb, fruits reached diameters of 60.8 mm and length of 90.4 mm, which was statistically significant compared to control trees, with 55.5 and 77.9 mm on fruit diameter and length, respectively.

■ Assessment of application of product stimplex (*Ascophyllum nodosum*), Hass avocado in order to measure the effect on floral induction, grams and harvest fruit diameter

M. Mattar Fajardo, R. Hernandez.

Avocado cultivation in Chile presents the phenomenon of alternate bearing and along with this year ON predominantly small fruit sizes over large. Stimplex product application was evaluated in different doses in order to determine the effect on the following parameters in adult Hass Avocado:

1. effect on floral induction. Number of flowering panicles located in one quadrant of 50 x 50 cm for each side of the tree in each treatment was evaluated.
2. the average weight of fruit and ecuatorial diameter.

Materials and methods

The trial was located in the area of Ovalle, Chile. Hass avocado planted 5 years old to 6 x 3 m, slope of the hill. The irrigation system is drip with emitters spaced 50 cm, 4 lt / hr. Double line. Applications were made based on the time when the conditions for flower induction in avocado corresponding when the maximum temperature decreases and is situated close to 20°C are given. This time for Ovalle area for the month of april. Were selected 10 trees per treatment. The design was completely random. The treatments correspond to:

Absolute control T0, T1 Stimplex 144 cc (8 cc / lt), T2 Stimplex 216 cc (12 cc / lt), T3 144 + 90 cc cc stimplex Paclobutrazol (8 cc / lt + 5 ml / l), T4 paclobutrazol 90 cc (5 ml / l). For each treatment 1.8 liters of broth per tree.

Stimplex treatments fall at different doses was observed that the application has a positive effect on improving the weight, fruit diameter and number of flower panicles in spring. Only in grams per fruit T1 it is less than T0.

■ Nutrient extractions on avocado (*Persea americana* M.) harvesting under coastal condition of Peru

A. Pacheco Avalos, P. Mamani Huertas

Facultad de Agronomía. Universidad Nacional Agraria La Molina.

The current work was taken on two commercial field of avocado 'Hass' plant trees located at Cañete (Lima) and Nazca (Ica) provinces in the central coast of Peru. The main goal was to determine the amount of nutrient extractions from a harvest of avocado fruits. Forty plant trees were labeled to sample 10 avocado fruits from each tree. Avocado fruits were analyzed in the Analysis Laboratories of Horticultural Products and Soil, Plant, Water and Fertilizers, both units managed by Faculty of Agronomy based at UNALM. Fresh and dry weights and nutrient concentrations on each fruit component such as peel, pulp and seeds were measured in advanced. Results from nutrient extractions per ton of fruits were 2.2-2.6 kg of N, 0.3-0.4 kg P, 3.3-3.6 kg K, 0.11-0.13 kg Ca, 0.17-0.20 kg Mg, 0.11-0.13 kg S, 12-19 g B, 10-11 g Fe, 2.0-2.2 g Cu, 1.6-1.8 g Mn, and 6.4-8.4 g Zn. In conclusion, these nutrient extraction values must be considered on the farmland fertilization program of avocado 'Hass' fruits.

■ Situation, progress and experiences in the development of Hass avocado in the Peruvian highland

G. Parodi¹.

¹. Universidad Nacional Agraria La Molina

This paper aims to show the development achieved in recent years by the 'Hass' avocado crop in the Peruvian highlands. The regions in which they are generating new projects with this variety, opportunities, challenges and the experience gained by companies and associations of producers who have opted for this variety and looking to participate with an exportable supply and wish to benefit the commercial window between January to April present in the European market.

■ Plant growth regulators for 'Hass' avocado production under rain-fed conditions in Brazil

S.R. Da Silva, T. Cantuarias-Avilés, B.A. Brogio, S.F. Angolini, L.I. Cagale

Universidad de São Paulo, Piracicaba, São Paulo, Brasil.

Plant growth regulators are one of the main management strategies for increasing avocado productivity. Nonetheless, information on the use of these products in rain-fed avocados is scarce. Therefore, a trial was conducted in a 10-year old commercial 'Hass' avocado orchard located in the southeastern region of São Paulo State (23°07'S, 49°30'W, 695 m altitude). The following treatments were sprayed: water (T1); 250 mg/L Viviful® (68,75% mg/L Prohexadione-Ca, T2); 0,7% Cultar® 250 SC (0,175% paclbutrazol, T3); 0,7 % Sunny® (0,035% uniconazole, T4); 25 mL/tree Moddus® (6,25 mL/tree trinexapac-ethyl, T5), and 1250 mg/L MaxCel® (25 mg/L 6-Benzyladenine, T6), by the time when 50% of maximum anthesis was observed. Another treatment (T7), consisting of 500 mg/L ProGibb® 10% (50 mg/L giberellic acid), was applied in December, before the onset of second fruit drop. The trial was conducted following a randomized complete block design, with seven treatments, four replications and two trees per replication, with a total of 28 plots (56 trees). No differences in fruit yield were observed in the first harvest, carried out seven months after treatment application, despite of the presence of larger length and diameter in fruit of T2, T3, T4 and T6 treatments. T3 and T4 treatments shortened spring vegetative shoots. Neither the flower intensity, nor the number and type of inflorescence were affected by any of the treatments. This trial is being currently assessed for the second consecutive year (2015).

Fungicida - Bactericida

Phyton 27[®]

SISTÉMICO

La decisión inteligente para el éxito de sus cultivos.



- Eficaz control de hongos y bacterias que desarrollan dentro y fuera de la planta.
- Puede ser utilizado en cualquier etapa del cultivo y cumplir con los LMR más exigentes.
- Permite un Programa Fitosanitario económicamente estable.
- Frutos sanos para un mercado cada vez más exigente.



Serfi SA[®]

Tecnología para la ECOeficiencia de sus cultivos

Av. Oscar R. Benavides (Ex Diagonal) 380 Of. 701 Miraflores - Lima | e-mail: clientes@serfi.com.pe
Ventas: 446-2896 | Administración: 446-7082 | Fax: 444-3287 | www.serfi.com.pe

■ Phenology of the 'Méndez' avocado in Southern Jalisco, Mexico

S. Salazar-García¹, M.E. Ibarra-Estrada², J. González-Valdivia²

¹. INIFAP. Santiago Ixcuintla, Nayarit, México. Correo-e: samuelsalazar@prodigy.net.mx

². Investigadores independientes. Santiago Ixcuintla, Nayarit, México.

The 'Méndez' avocado has become important because a significant proportion of its annual crop matures earlier (summer) than 'Hass' (fall). In Southern Jalisco there are more than 6,000 ha of 'Méndez'; however, orchard management practices are similar to 'Hass', therefore it is necessary to develop proper technology for 'Méndez'. The goal of this research was to assess the phenology of the aerial and root parts of 'Méndez' in the Semiwarm subhumid climate of Southern Jalisco. Two 5-year old irrigated (annual rain 728 mm) commercial 'Méndez' orchards from the Agro González company established on a Feozem Haplic soil were used. The first flowering flush occurred in winter (February) and the second in summer (August). Vegetative flushes (VF) were present in winter (February; more intense) and summer (August-September; less intense). Floral development (vegetative bud through anthesis) in winter and summer VF lasted 218 and 200 days, respectively. Fruit maturity (22% d.m.) occurred in July and October 2014 for fruit from the summer 2013 and winter 2014 blooms, respectively. Crop per tree ranged from 32 to 37 kg for each type of bloom (9.1 to 10.6 t-ha⁻¹; at 7 x 5 m). Greatest root production occurred from July to September (rainy season). Average ambient temperatures for the hottest (May) and coldest (January) months, were 33 and 6 °C, respectively. Highest soil temperature (at 30 cm) recorded occurred in May and July (27.4 °C) and the lowest in March (18 °C). Research funded by INIFAP and Agro González, S.P.R. de R.L.

■ Influence of the type of climate on root phenology of 'Hass' avocado in Michoacan

S. Salazar-García¹, J.L. Rocha-Arroyo², M.E. Ibarra-Estrada³

¹. INIFAP. Santiago Ixcuintla, Nayarit, México. Correo-e: samuelsalazar@prodigy.net.mx

². Investigador independiente. Uruapan, Michoacán, México.

³. Investigador independiente. Santiago Ixcuintla, Nayarit, México.

To improve the efficiency of fertilization and other cultural practices in avocado is important to know root phenology. The objective of this study was to quantify the intensity and dates of occurrence of root growth flushes in 'Hass' avocado cultivated in four types of climate (Warm subhumid, Semiwarm subhumid, Semiwarm humid and Temperate subhumid) of Michoacan. Seven orchards of 'Hass' on native Mexican seedling rootstocks were chosen and in each orchard, 12 trees were selected. Production (dry weight) of new roots was quantified monthly in the canopy's shadow area of two trees per orchard, by extracting soil from a 30x30x30 cm excavation. A greater production of roots occurred in the Semiwarm subhumid and Semiwarm humid climates. In all climates, root production occurred throughout the year; however, there were two periods of maximum production whose time of occurrence varied with the type of climate: February-April and October (Semiwarm subhumid); March and September (Semiwarm humid); April and December (Warm subhumid); June and December (Temperate subhumid). Rainy season (June to October) rainfall was 1,050, 1,070, 1,380, and 1460 for the Semiwarm subhumid, Temperate subhumid, Warm subhumid, and Semiwarm humid climates, respectively. Annual root production was higher in rainfed orchards (31.7 g) than in the irrigated ones (18 g). Warmer soil temperatures (at 30 cm depth) were recorded in June and July (20.8 °C) in the Warm subhumid climate while the lowest (14 °C) occurred in January in the Semiwarm humid and Temperate subhumid climates. Research funded by INIFAP, CONACYT, APEAM, CONAPA and COMA.

■ Time of bloom affected nutrient removal of 'Hass' avocado fruit

S. Salazar-García¹, M.E. Ibarra-Estrada²

¹. INIFAP. Santiago Ixcuintla, Nayarit, México. Correo-e: samuelsalazar@prodigy.net.mx

². Investigador independiente. Santiago Ixcuintla, Nayarit, México.

To improve fertilization practices for 'Hass' avocado in Michoacán the influence of the time of bloom (anthesis): "crazy" (Aug.-Sept.), "normal" (Dec.-Feb.), and "marceña" (Feb.-Mar.) on fruit nutrient removal was evaluated. Six commercial 'Hass' orchards established in the major types of climate that comprise 94% of avocado land in Michoacan were selected. Trees used at each orchard were two for "crazy" bloom, two for the "normal" bloom and four for the "marceña" bloom. For each tree, two independent samples for each fruit tissue (skin, pulp, seed coat and embryo) were prepared. Each sample was composed of tissue from five out of 10 fruit per tree obtained in each of the six orchards. In total, 384 fruit samples from fruit harvested in legal maturity ($\geq 21.5\%$ dry matter of the pulp) were analyzed. Concentration of N, P, K, Ca, Mg, S, Na, Cl⁻, Fe, Cu, Mn, B and Zn was determined in dry matter. Fruit nutrient removal was calculated by adding the content of each nutrient in the fruit parts, considering their fresh and dry weights. Removal of most nutrients analyzed (N, K, Ca, Mg, S, Na, Fe, Cu, and Mn), by the fruit of the "marceña" bloom (harvested in January) was higher than that of the "crazy" (harvested in July) and "normal" (harvested in October) blooms. Research funded by INIFAP, CONACYT, APEAM, CONAPA, and COMA.

Nutrient removal by 'Mendez' avocado fruit in Southern Jalisco, Mexico

A. Mellado-Vázquez¹; S. Salazar-García¹; A. Álvarez-Bravo¹; M.E. Ibarra-Estrada²; J. González-Valdivia²

¹. INIFAP. Santiago Ixcuintla, Nayarit, México. Correo-e: samuelsalazar@prodigy.net.mx

². Investigadores independientes. Santiago Ixcuintla, Nayarit, México.

The 'Mendez' avocado presents an early flowering whose fruit is harvested at the time of low crop production of 'Hass', achieving a higher price. The difference in phenology between both cultivars require a different orchard nutrition management. The goal of this study was to quantify the removal of nutrients by fruit tissues (skin, pulp, seed coat and embryo), as well as the crop total nutrient removal in commercial 'Mendez' orchards in Southern Jalisco. Two orchards of the Agro González company where selected, which were five-year old, under irrigation (annual rainfall 728 mm), established on a Haplic phaeozem soil and Subhumid warm climate. In each orchard, 10 trees with a minimum crop of 30 kg tree⁻¹ were selected. When the pulp of the fruit reached 22.5% dry matter, 10 fruit per tree were collected and the fresh and dry weight of each fruit tissue recorded. The content of N, P, K, Ca, Mg, S, Fe, Cu, Mn, Zn, and B was determined and used to calculate nutrient removal. Potassium was the nutrient with the highest concentration in the four tissues, followed by N. Other nutrients showed the following order of concentration: P and Mg>Ca>S>B>Fe>Cu>Zn>Mn in the skin; P>Mg>Ca, S and B>Fe>Zn>Cu>Mn in the pulp; Mg>Ca>P>S>B>Fe>Mn>Cu>Zn in the seed coat and P>Mg>Ca>S>Fe>B>Zn>Cu>Mn in the embryo. Total nutrient removal per ton of fresh fruit had the following order of magnitude: K>N>Mg>P>Ca>S>B>Fe>Cu>Zn>Mn. Research funded by the INIFAP and Agro González, SPR of RL.

Validation of a 'Hass' avocado floral development prediction model in Michoacan, Mexico

A. Álvarez-Bravo, S. Salazar-García

INIFAP. Santiago Ixcuintla, Nayarit, México. Correo-e: samuelsalazar@prodigy.net.mx

In avocado, changes in environmental conditions triggers floral development and temperature is the main factor involved. In previous research, a floral development prediction model (FDPM) was obtained for winter vegetative flush shoots (emerged during the main bloom) of 'Hass' avocado cultivated in various climates of Michoacan. Temperatures recorded by battery-operated devices at each experimental orchard were used. It is unknown the accuracy of the FDPM once it is feed via internet by the Automated Weather Stations Network (AWSN) that the Association of Producers and Exporting Packers of Avocado from Mexico has installed in Michoacán. The objective of this research was to validate the FDPM feed by the AWSN in the four major climates where 'Hass' is cultivated. The AWSN supplied data via internet to the prediction model and generated a database of simulations. Monthly sampling of apical buds and inflorescences in 10 trees at each of 12 orchards located through the Dry semiwarm subhumid (ACW1), Semiwarm subhumid (ACw2). Temperate subhumid (Cw2), and Humid temperate (Cm) climates were made. Validation of the FDPM showed excellent accuracy to predict any stage of floral development (from vegetative stage to anthesis) of 'Hass' winter shoots in more than 100 thousand hectares in Michoacán. The R2 value for the ACW1 and ACw2 climates was 0.94, for Cw2 it was 0.96 and 0.95 for the Cm climate. Research funded by INIFAP.

Progress of the study of the effect of different volumes of water on the physiology and crop yield avocado var. Hass, under saline conditions in Chilca, Peru

K. Vasquez¹, O. Diaz², J. Escobedo³, A. Rodriguez⁴

¹. Asociación de productores de palta Hass del Perú, Lima, Lima, Perú.

². Agropecuaria Las Lomas de Chilca, Lima, Lima, Perú.

³. Universidad Nacional Agraria La Molina, La Molina, Lima, Perú

⁴. AGQ Labs, Lima, Perú

The avocado is highly sensitive to water stress and salt, two of the most relevant problems on the coast of Peru, making irrigation management a difficult task for grower's fruit species. Salinity affects soil composition and prevents the plant to absorb water through the roots, weakening the vegetative growth and fruit development. Therefore, an experiment was conducted in an avocado commercial orchard var. Hass in the region of Chilca, located 67 km from the city of Lima, this zone have water electrical conductivity (EC) of 0.6 dS/m and 1.07 dS/m in the soil, levels that causes critic salt accumulation during the avocado flowering period in September. The study involves four treatments: T0: Control aprox. 100% ETo, T1: 80% ETo, T2: 120% ETo and T3: 150% ETo. Drip irrigation system is use for water supply, the irrigation scheduling, frequency and time, was determined according to a recommended crop factor of 0.75 and evapotranspiration was recorded through a meteorological station located in the study area, also an amount of water needed to leach salts below the root zone was applied. Shoot growth and development of indeterminate flowers panicles, the behavior of electrical conductivity in the soil, levels of N, P, K and chlorides in the leaves and yield first count were assessed. According to preliminary results, T2 has induced in a 22.33% the appearance of vegetative second flow in comparison to the control treatment with 15.67%, the electrical conductivity of the T3 had a better effect with an average of 0.89 dS/cm compared to T0 with 1.32 dS/m at two depths. The first fruit count, three months before harvest, states that T3 seems to be the best treatment with an average of 186.52 compared to T0, T1 y T2 that reach out an average of 122.12, 116.76 and 135.16 respectively.