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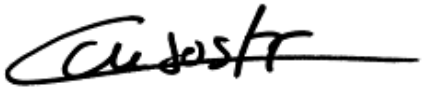
October 2010
Vol. 19, No. 4



Carlos H. Crisosto, Editor

ABSTRACTS FROM KIWIFRUIT MEETING IN ITALY

The following abstracts are from the 7th International Symposium on Kiwifruit hosted by Alma Mater Studiorum, University of Bologna (Italy) and Emilia-Romagna Region from September 12 to 17, 2010 in Faenza, Italy.

Cultural Management

Dormancy, Propagation, Training systems and pruning, Pollination, Plant nutrition, Water management, Growth regulators

Optimizing Kiwifruit Vine Performance for High Productivity and Superior Fruit Taste

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Kiwifruit production systems in New Zealand are driven by the need to achieve both high productivity (yield of Class 1 fruit per hectare) and superior fruit taste for consumers. Fruit dry matter content at harvest (DMC) is used as a proxy for potential taste of ripe fruit and growers receive incentives to produce high DMC fruit. High DMC fruit would be considered to be c. 17% for 'Hayward' and c. 18.5% for 'Hort16A', with starch accounting for most of the dry matter at commercial harvest. Vine management systems need to focus on both the attainment of optimum fruit number and fruit size per unit area of canopy as well as maximizing the partitioning of carbohydrate to the fruit, to achieve this high starch content. A number of novel vine

management techniques are being introduced to manage dry matter accumulation in fruit. For example, girdling techniques provide short-term interruption to carbohydrate flow and have positive effects on both fruit growth and carbohydrate import. Choice of moderate to low vigor cane types and summer pruning techniques which minimize competition between vegetative growth and fruit growth can affect the taste profile of fruit considerably. Top performing growers can consistently deliver both high productivity and high taste potential: we will discuss how they integrate a range of management techniques to achieve these outcomes.

Sustainable Orchard Management, Fruit Quality and Carbon Footprint

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Sustainable kiwifruit production should involve the adoption of a number of practices with the main objective to improve fruit quality, minimize the environmental impact and increase soil fertility. The use of cover crops and compost applications are some common techniques to enhance soil organic matter, improving water infiltration rate and communities of soil microorganisms. Intensive agricultural practices (continuous tillage, intensive use of mineral fertilizers, use of low-quality irrigation water) combined with low precipitation and high summer temperatures have dramatically degraded cultivated soils from chemical and microbiological point of view. In addition, soil hydrological properties are impaired and soil water-holding capacity reduced. The balanced mineral nutrition is very important for fruit quality at harvest and their storage life. For a correct fertilization plan we should take into account the amount of nutrients supplied by soil and by irrigation water in relation to plants' mineral uptake during the different growth stages of the year. Particular attention must be paid to the calcium accumulation into fruit since it improves fruit quality and reduces the incidence of some physiological disorders. Calcium content of fruits is not correlated to the calcium availability in the soil or its concentration in the leaves; it is mainly associated with microclimatic conditions near the fruits which influence their transpiration. Leaf applications of calcium-based chemicals should be done within the first 6-7 weeks after fruit set; afterwards the calcium remains on the skin and cannot reach the flesh. Sustainable management practices could influence the orchard-atmosphere carbon flux, via increasing the CO_2 sequestration and reducing the emissions. Based on the CO_2 emissions (orchard, storage, packaging and transportation) and CO_2 sequestration (photosynthesis, compost, etc.), an example of carbon flux is presented and the carbon footprint discussed.

Modelling *In Vitro* Culture Propagation of Kiwifruit Using Artificial Intelligence (AI)

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It has been suggested that in the future it will be required to have a broader view of plant systems in the plant research field. Currently, different technologies catapult to researchers a new influx of high-throughput data from different levels of biological organization. Biological processes are both time variant and nonlinear in nature, and their complexity can be understood as the composition of many different and interacting elements governed by non-deterministic rules and influenced by external factors. *In vitro* propagation requires optimized processes which can take into account the factors influencing them (genetic, environmental, etc.). Artificial intelligence (AI) technology can be used for modeling and

predicting the combination of variables that yield the optimal results. After decades of developing plant tissue culture techniques and methodologies, AI offers the possibility of achieving the whole view of the experimental study with a limited number of experiments and costs. This approach showed new advantages over traditional analytical methods allowing an accurate description of parameters at different levels as photosynthesis and growth parameters, modeling and optimizing the *in vitro* kiwifruit propagation. Additionally, deeper knowledge can be obtained by adding new inputs and outputs to the database, appearing as an emergent and interesting analytical tool to increase the *in vitro* culture knowledge. The potential of AI technology for analyzing *in vitro* kiwifruit propagation, and in a broad sense complex plant research data, is discussed in this work.

Budbreak: Safe and Efficient Solution from NZ Experience on Hort16A (Zespri Gold) and Hayward

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Different strategy and chemical compound has been tested for poor bud break when winter chilling requirements are not satisfied in subtropical condition (Erez, 1987). Only few of this solution are successfully applied in the field. In the warm temperate NZ climate three years of trials with an E.C. fertilizer, nitrogen solution with calcium, testing different rate on Hayward (only one rate has been tested on Gold) and timing of application, starting from 50 days before natural budbreak, the most important variable, showed good result on Kiwi Gold (Hort 16A) and Hayward budbreak. An earlier bud break, up to 1 week anticipate in comparison with untreated, and good uniformity of the shoot along the cane. Generally expect an improved % bud break, + 15% in comparison with untreated as concern Gold, and more flowers per winter bud (+56%). More fruit per unit area is expected compared to the untreated, (+36 %.) Measured fruit size indicates that despite the higher number of fruit per hectare, the fruit size of untreated 115 g is not statistically significant different from the BudBreaker treated fruit size 112g.

Necessity to Change the Cultivation Systems for Improving Pollination in Kiwi Orchards in Iran

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Main factor for fruit formation in kiwifruit vine and the most other fruit trees is pollination. In kiwifruit pollination is done by wind and insects especially by honeybee and in some countries additive pollination is done by hand. Main factors in pollination are: climatic condition during bloom, management in orchard and activity of pollenizer, viability of pollen, suitable amount of male and female trees, good system of distribution of male and female trees. Bees activity, as main factor for fruit production, in temperature between 17-20 centigrade degrees is the most. Have good knowledge in the bees behavior and doing the proper managing system as: providing adequate amount of beehives in the best time and place in orchard, and pushing bees to kiwifruit flowers cause improving pollination. Cultivation system is another main factor in improving pollination. In kiwi orchard, when male and female trees are in different proportion of 1:6, 1:5, 1:3 (in normal spacing of 3*5 meter) in turn 21, 32 and 92 trees are diminished. If each bearing tree production estimated 50 kg, in turn there will be 1050, 1600, 4500 kg low production in one hectare. For that reason in all the kiwi orchard 1:8 portion is accepted. In cultivation systems and spacing of trees, it is important to see the behavior of bees as bees more love to fly within the rows of trees and not between them. So the suggestion for establishing kiwifruit orchard is

distributing adequate male trees in all rows that will improve pollination and have good quality product.

Effects of Ground Mulching on Soil Condition and Plant Growth in Kiwifruit

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High summer temperature and drought significantly affect fruit yield, quality, appearance and storage life of kiwifruit. It is important to find a solution to overcome these problems. From 2006, we have studied the effects of ground mulching, using rice husk as the mulching material, on soil conditions and plant growth of kiwifruit in Changsha. The results showed that rice husk had a strong water-holding capacity, with saturated moisture content up to 1.4 times of its own weight. Both husk and "husk + film" treatments substantially lowered the temperature of surface soil layer and maintained at a more constant state, and effectively reduced soil moisture loss. They also increased soil organic matter content and microbial activity. Defoliation of kiwifruit plant was significantly reduced as a result.

Effects of Plant Vigor on Flower and Fruit Development in Kiwifruit

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This study investigated the relationship between plant vigor and flower number and fruit size and quality of three kiwifruit cultivars, i.e. *A. chinensis* cultivars 'Cuiyu' and 'Chuhoung', and *A. deliciosa* cultivar 'Miliang-1'. Results showed that plant vigor was an important factor affecting flower number and fruit growth and development. The flower number of more vigorous plants was up to two times higher than that of weaker plants; the average fruit weight was 1.4-1.8 times of that of weaker plants. Fruit from more vigorous plants also had significantly higher soluble solids content and better storability than that from weaker plants. The proportion of long shoots (≥ 100 cm) at the end of the shoot growth season can be used as an indicator of plant vigor. For the three cultivars studied, vigorous plants should have more than 30% long shoots for both 'Cuiyu' and 'Miliang -1', and more than 40% long shoots for 'Chuhong'.

Genotypic Control of Carbon Accumulation in *Actinidia deliciosa* Genotypes

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Dry matter is an important quality trait in kiwifruit as it correlates with the consumer's perception of fruit flavor and hence is used in New Zealand as one of the determinants of growers' returns as well as a key screening criterion for selecting new varieties. Dry matter is a complex trait under polygenic control and is often negatively correlated with fruit size, hampering selection of new, high dry matter, large kiwifruit varieties. Total non-structural carbohydrates (mainly starch) make up about 75% of fruit dry matter. We have found that fruit from high dry matter genotypes are characterized by the ability to accumulate more starch during fruit development when compared with fruit from low dry matter genotypes. Examining the starch metabolic pathway in these contrasting genotypes, showed that higher expression levels of a sucrose synthase gene and an ADP-glucose pyrophosphorylase large subunit gene early in fruit development, were observed immediately before a dramatic increase in starch levels in

high dry matter genotypes. Preliminary results from this work will be presented.

Leaf Gas Exchanges Affect Water Flows to Kiwifruit Berries During the Day

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Daily fluctuations in environmental conditions largely affect leaf gas exchanges and leaf water status. These changes impact the force with which leaves are able to attract water from the vascular system, and may affect water flows at whole tree level. This work studies daily leaf and fruit water relations to test whether leaf gas exchanges affect water flows to the fruit during the day. The daily patterns of leaf photosynthesis, stomatal conductance and transpiration were monitored on well-exposed shoot leaves of the cultivar Summerkiwi 6 weeks after full bloom. In the same period, phloem, xylem and transpiration flows to/from the fruit were quantified by recording the diurnal patterns of intact kiwifruit berries, which were then girdled and subsequently detached, using highly sensitive, custom-built fruit diameter gauges. The daily patterns of leaf and stem water potentials and of fruit pressure potential in the xylem were also determined using a pressure chamber. All leaves and fruit were sampled on the east- side of the row. Stomatal conductance and leaf gas exchanges were highly related during the day, being high in the morning and decreasing in the afternoon, in correspondence with the increase in vapor pressure deficit. These changes affected leaf water potential which decreased sharply in the morning, as transpiration rose, reached a minimum at about 10.00 and increased thereafter. On the other hand, the fruit pressure potential, which was closely related to fruit transpiration, reached a daily minimum later than the leaves, so that stem-to-fruit pressure potential gradients were low in the morning and increased during the afternoon. As xylem flows respond to pressure potential gradients in the xylem vessels, the xylem flow to the fruit was low, and even negative in the morning, increased in the afternoon and maintained high values during the night, in accordance to the daily pattern of the stem-to-fruit pressure potential gradient. Phloem flow to the fruit was much lower than the xylem's during the day and showed a peak during the midday hours. These results show that when leaf transpiration rate is high, as occurs in the morning, most of the water available at whole tree level is directed to the leaves due to their negative water potentials. Then, as leaves close their stomata during the afternoon, an increasing amount of water becomes available for the fruit thanks to an increase in the stem-to-fruit water potential gradient. Water flows to kiwifruit berries are highly affected by leaf gas exchanges during the day.

Manipulation of Fruit Water and Dry Matter Content During Early and Late Stages of Fruit Development in Kiwifruit

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During late Stage 1 of fruit development and again during late Stage 3, cells within the fruit of kiwifruit (*Actinidia deliciosa*) have increased capacity for expansion and water uptake. To investigate fruit water uptake, 14 mature T-bar vines were subjected to a range of treatments designed to manipulate the osmotic and water potential gradients to the fruit at the two critical times identified. Treatments included supplying vines with surplus water by frequent irrigations; increasing the supply of assimilates by girdling and treatment with the plant growth regulator, CPPU; supplying supplementary nitrogen with foliar urea sprays; and alteration of the transpirational flux to the fruit by wrapping the fruit in foil. Surplus water, CPPU, and girdling alone or in various combinations all increased fruit water more than fruit dry matter (DM). Inhibition of transpiration during late Stage 1 of fruit development severely reduced fruit water and dry matter

accumulation by 14% and 32% respectively. Foliar sprays of urea over the same treatment period gave some further increases in fruit water content but nearly doubled fruit DM increases compared to treatments with no urea. Therefore foliar urea may be useful to compensate for the reduced DM concentration sometimes associated with the stimulation of fruit growth by growth regulators, irrigation, and/or girdling.

Frost Damage on Kiwifruit in Iran

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Because of freeze damage on citrus industry in Northern Iran, different subtropical fruit trees were evaluated at Ramsar Citrus Experimental Station during 1962-1974 and kiwifruit was selected and valued in 1974 as a very cold hardy alternative for citrus in Caspian Sea region where the environmental condition is suitable for kiwifruit growing in Iran. In January 2008, a very heavy snowfall following distractive freeze (-14°C), killed 50 ha five years old kiwifruit vines up to surface of the soil in Lakan, Rasht (Guilan province). This paper will discuss all about this very distractive frost and the results, which have obtained.

Increasing Productivity of Alternate Year Cropping Systems for ZESPRI® GOLD Kiwifruit ('Hort16A')

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Alternate Year Cropping (AYC) is a string-assisted growing system that is used to crop a single row of vines over the combined pergola area of two rows, in every second year. Non-cropping vines are required only to grow replacement fruiting canes trained onto strings extended high over the top of the fruiting canopy of adjacent cropping vines. In the following year, the roles are reversed and the fruiting canopy of the previously cropping vines is totally removed and the replacement cane canopy produced on the previously non-cropping vines is tied down, once again to extend across two rows. For ZESPRI® GOLD kiwifruit ('Hort16A') in New Zealand, yields of up to 18,000 Class 1 trays/ha (59.4 t/ha) have been achieved with AYC. Projects were established in 2006 to see if yields of AYC vines could be further increased by using reflective ground covers, applying minimal pruning to increase leaf:fruit (L:F) ratios and closer cane spacing to give more canes and thus more fruit per vine. Reflective ground covers increased the number of flowers/fruit per cane and subsequently increased vine yields by 2,330 trays (13%) to 19,896 trays/ha (65.7 t/ha) of Class 1 fruit. Fruit weight (FW) was not affected, even with the higher crop loadings, yet fruit had higher dry matter concentration (DM) than fruit from control vines. Increasing leaf area per vine had no apparent effect; vines with a high L:F produced fruit with similar FW and DM to fruit from vines with low L:F. Increasing crop load by increasing the number of canes per vine reduced average FW from 108 to 100 g, so there was no net gain in yield of Class 1 trays. In conclusion, better irradiance in the existing canopy induced a 13% increase in yield, whereas increasing canopy leaf area by higher L:F ratio or increasing the number of fruit per vine both failed to increase yields.

Careful Use of Girdling and Biostimulants is Needed to Promote High Yields of High Quality 'Hort16A' Kiwifruit without Compromising Canopy Development or Fruit Quality

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Girdling 'Hort16A' kiwifruit vines can increase mean fruit weight, dry matter content at harvest (DMC) and flowering in the following season. We have found that when used appropriately,

there are generally no negative consequences of girdling on long-term vine performance. In recent years, management of 'Hort16A' kiwifruit vines has focused on how to counter the strong vegetative growth that occurs in this cultivar in spring and early summer. Although trunk girdling the vines can reduce some of the excessive vigor of 'Hort16A' kiwifruit, pruning gels that contain naphthalene acetic acid (NAA) are available that can be used to reduce this substantially. However, we have discovered that NAA gels applied to cut shoots were also able to produce a fruit growth biostimulant effect, in that they promoted very substantial increases in fruit weight. Although both girdling and NAA gels have proved to be valuable vine management tools for kiwifruit growers, we outline cases where their incorrect application has compromised fruit yield or quality. Selective and targeted use of these tools is needed to make the most of their potential to maximize orchard profitability.

Plant Protection

Pests and diseases, Orchard and environmental protection

Recent Advances in the Characterization and Control of *Pseudomonas syringae* pv *actinidiae*, the Causal Agent of Bacterial Canker on Kiwifruit

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Bacterial canker of kiwifruit is caused by *Pseudomonas syringae* pv. *actinidae* (Psa) and affects *Actinidia deliciosa* as well as *A. chinensis*. Psa was first described in Japan in 1984 and was found in Korea and in Italy in 1992. A new outbreak of Psa occurred in Latina (Italy) in 2008. Little is known about this pathogen, rendering the control of the latest outbreak difficult. Since the knowledge of the life cycle would help the development of a strategy of control, tools and techniques to study the life cycle of the pathogen are being developed. Some of the newer tools that have been developed or that are being developed (such as detection of the pathogen in symptomless tissues by Bio-PCR) will be described. The typing of the different strains of the pathogen present in the world has been initiated to study the epidemiology of Psa and to help understand the source of the recent Italian outbreak. The molecular variability of Psa has been analyzed using multi-locus sequence typing analysis and repetitive PCR. Two haplotypes for the housekeeping gene *cts* (*glt*A) have been found. The Japanese, the Korean and the two strains isolated in Italy in 1992 shared the same haplotype, while all the strains isolated in Italy since 2008 shared the other haplotype. Similarly by BOX-PCR, the strains of Psa can be divided in two different classes based on their fingerprints. There is a strong correlation between haplotypes and fingerprints: strains which share the same haplotype have a similar fingerprint. The implication of the existence of these two 'types' of Psa will be discussed. The recommendations given to growers today to control bacterial canker of kiwifruit will be presented in the context of our still limited understanding of the life cycle of Psa.

History of Kiwifruit Bacterial Diseases in Italy

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Bacterial diseases in Italian kiwifruit orchards are observed and studied since the end of '80. Three different populations (*Pseudomonas syringae* pv. *syringae*, PSS, *Pseudomonas syringae* pv. *actinidae*, PSA, *Pseudomonas viridiflava*, PV) of phytopathogenic bacteria are responsible for damages on kiwifruit organs. PSS and PV cause parenchimatic damages especially on leaves, buds and flowers; PSA affect vascular tissues causing remarkable loss

also on whole plants. PSS and PV have been recorded in the most important kiwifruit areas (Lazio, Emilia Romagna, Veneto, Piedmont, Calabria) causing floral necrosis and bacterial blight, respectively. PSA, responsible of bacterial canker, until now affects kiwifruit orchards in Lazio region (Latina and Rome provinces); sporadically it was found also in Emilia Romagna and Veneto regions. Kiwifruit bacterial diseases have been recorded on different *Actinidia* spp. (*chinensis*, *deliciosa*) causing loss on main cultivated cvs. of green and yellow kiwi fruits. Environmental conditions (rainfall, hail, frost, humidity, temperature, wind) affect epiphytic survival and their epidemiology; pruning phases and nutrition practices, the same, play an important role on these pathogens. Control strategies by different approaches characterized by low environmental impact were tested. Results until now obtained and research in progress are discussed.

Real Time Monitoring of the Pathogenic Interactions between *Pseudomonas syringae* pv *actinidiae* and *Actinidia* species

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To elucidate the infection process and the colonization of plant tissues by *P. syringae* pv *actinidiae*, different strains of the bacterium were transformed with a stable and broad-host-range plasmid vector (pDSKGFPuv) that strongly expresses the GFPuv protein. In comparison with the wild-type GFP, GFPuv produces 45-fold brighter green fluorescence in bacterial cells, while it retains the same excitation and emission maxima. In addition, GFPuv is a more soluble protein and does not produce, like wtGFP, nonfluorescent inclusion bodies. Finally, GFPuv has lower toxicity to bacteria than wtGFP. For these reasons, the use of GFPuv may potentially allow the direct observation of the bacterial colonization directly with naked eye under long-wavelength UV light (395 nm). The plasmid stability and the possible effect on *P. syrinage actinidiae* growth and virulence were tested both *in vitro* and *in vivo*. Successively, the colonization of the plant tissue was monitored *in planta* on intact, viable plant tissues without any kind of staining of the specimens. The described methodology allows a non invasive observation of the plant-pathogen interaction both at the cell and whole plant level, therefore, it may also be applied for investigating the influence of agricultural and phytosanitary practices on the host susceptibility and disease development.

Actinidia is a Natural Host to a Wide Range of Plant Viruses

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At the 6th International Symposium on Kiwifruit in 2006 we reported the presence of *Apple stem grooving virus*, *Ribgrass mosaic virus* (*Tobamovirus*) and a 700-750 nm flexuous virus in *Actinidia* accessions from China. The flexuous virus was subsequently sequenced and shown to be closely related to *Citrus leaf blotch virus* (*Flexiviridae*). Although to date no obvious virus problems have been reported in commercial crops, further examination of kiwifruit germplasm has detected additional spherical and filamentous viruses from a range of virus families and genera. These include *Alfalfa mosaic virus*, *Cucumber mosaic virus*, *Cucumber necrosis virus*, a potexvirus and two novel vitiviruses. The biological properties of the viruses from kiwifruit and their phylogenetic relationships with similar viruses from other hosts will be described and the possible implications for the kiwifruit industry discussed.

Phytohormones in Kiwifruit Plants Affected by Elephantiasis

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Since 2001 an unusual disease, named elephantiasis, was observed in the kiwifruit cultivar 'Hayward' in orchards of Northern Italy. The symptom typical of elephantiasis in kiwifruit is trunk hypertrophy, with which a marked brown discoloration of the annual rings is associated. Fungi isolated from necrotic sections of plants are belonging to different fungal genera such as *Fusarium* spp, mainly *F. solani, Cylindrocarpon* spp and *Phialophora*-like, that includes *Phaeoacremonium*, *Cadophora*, and *Lecythophora*. The kiwifruit plant tissue colonization capacity of *P. aleophilum*, *Cadophora melinii* and *F. solani* was verified, while pathogenicity trials using these fungi are in progress in an experimental field. To explain the trunk hypertrophy, trunks of diseased and asymptomatic plants coming from the same orchard were analyzed for the presence of phytohormones by HPLC-ESI-MS/MS. The hormones analyzed were abscisic acid (ABA), jasmonic acid (JA), salicylic acid (SA), indole-3- acetic acid (IAA) and gibberellins (GA1, GA3, GA4, GA34). The level of these hormones showed a similar trend in diseased and asymptomatic plants, except GA34 which was detected exclusively in diseased plants. Gibberellins (GAs) are a large family of hormones that regulate germination, elongation growth and sex determination in plants. GAs are also produced by some fungi and might induce abnormal tissue growth of plants. These results induce us to further investigate the possible direct production of gibberellins by the fungi associated to this unusual disease and their involvement in the trunk hypertrophy.

Outbreak of a Lethal Wilt Form of Gold Kiwifruit, *Actinidia chinensis* cv. Hort 16A in Chile

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Zespri™ Gold kiwifruit, *Actinidia chinensis* Planch cv. Hort 16A, growing under license in Chile began in 2003. By 2006, 150 ha of Hort 16A had been established, and vines started dying within 2 years. By the end of the 2008-2009 growing season, as many as 80% of the plants in several orchards had died. The disease was characterized by a sudden wilting and dieback of plants any time during the growing season. In the spring, entire plants or parts of plants failed to break buds. In others, the buds broke, but juvenile leaf clusters then wilted and died. On severely affected plants, scion watershoots wilted and died. The disease was apparently most severe in sites that had been planted to Gold kiwifruit immediately after removal of apple, pear, citrus, or grape. Orchards planted following long-term maize, wheat, or grass culture were almost disease free. A fungus was consistently isolated from symptomatic vascular tissue. On the basis of morphological characteristics and by sequencing part of the internal transcribed spacer (ITS) region with primers ITS1 and ITS4, the fungus was identified as *Verticillium albo-atrum* Reinke & Berthier. To complete pathogenicity tests, 20 healthy, 1-year-old Hort 16A kiwi vines grafted on Hayward kiwifruit (*A. deliciosa* Chevalier) seedlings were inoculated. Eight weeks after inoculation, typical wilting and dieback symptoms developed on 90% of the plants. Control plants injected with water remained healthy. Verticillium wilt has never been reported on kiwifruit (*A. deliciosa*) in Chile. *V. albo-atrum* has a rather narrow host range and is mainly reported as a pathogen on alfalfa, hop, soybean, tomato, and potato. This is the first report of *V. albo-atrum* causing wilt and dieback on Gold kiwifruit (*A. chinensis*) cv. Hort 16A.

Further Evidence on the Relationship between Sodium Content in the Soil and Incidence of Wood Decay in Kiwifruit

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The wood decay is a new chronic wood disease caused by different fungi with a complex aetiology not cleared yet. This harmful and spread disease is characterized by a correlation between yield losses and foliar symptoms appearance, which in turn have an erratic nature as decay of grapevine. A survey is being carried out on 10-year-old vineyards cv. Hayward, in which the wood decay appeared for the first time in 2003. Each year and for each vineyard, the incidence of the disease was assessed by recording the percentage of vines with foliar symptoms. Moreover, on each vineyard, the content of exchangeable sodium in the soil was evaluated. Finally symptomatic or asymptomatic leaves collected at different times during the growing season were analyzed for the content of sodium. The incidence of the disease as percentage of symptomatic vines increased with the content of exchangeable sodium in the soil, but did not seemed correlated with the content of sodium in the leaf.

Up Regulation of Putative Defense-Associated Transcripts Correlates with Elicitor-Induced Ripe Rot Reduction in 'Hort16A' Kiwifruit

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Pre-harvest elicitor application has been shown to reduce significantly the incidence of post-harvest ripe rots caused by *Cryptosporiopsis actinidiae* on *Actinidia chinensis* 'Hort16A' kiwifruit, but to date nothing is known about the mode(s) of action. Although infection by the pathogen occurs pre-harvest, it does not become symptomatic on the fruit surface until 12+ weeks of post-harvest storage. This study aimed to establish whether the resistance phenotype in elicitor-treated fruit, after 18 weeks of post-harvest storage, could be correlated with changes in gene expression. Pre-harvest application of benzothiadiazole (BTH) and methyl jasmonate (MJ), induced a 72% and 54% reduction in ripe rot incidence, respectively, compared with the control treatment. Real-time reverse-transcription polymerase chain reaction (qRT-PCR) was employed to investigate the transcriptional levels of seven putative defense genes in the treated fruit. A small, but noticeable up regulation of thaumatin-like protein (TLP), class I chitinase, class IV acidic chitinase, and especially glucan endo-1,3-beta-glucosidase (β-1,3- glucosidase) was observed in the BTH compared with the MJ and control treatments. The results support previous findings from the same research team, where the decrease in 'Hort16A' resistance over time and associated post-harvest increase in disease levels were associated with a reduction in endogenous TLP, class IV chitinase, and β-1,3-glucosidase transcripts.

Storage and Fruit Quality

Fruit ripening physiology, Harvesting, Cold storage strategies, Processing, Health attributes, Allergens, Quality assessment

Is Dry Matter a Reliable Quality Index for 'Hayward' Kiwifruit?

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Dry matter (DM) measurement at harvest or during postharvest handling is being proposed as a quality index for 'Hayward' kiwifruit because it includes soluble sugars, starch, and organic acids. During two seasons, using "in-

store" consumer tests, acceptance was directly related to DM. However, in a kiwifruit with high ripe titratable acidity (RTA), in addition to DM, RTA plays an important role in consumer acceptance. In 1998 and 2008 growing seasons, consumers "liked" kiwifruit that had DM ≥ 16.1%. In the 2008 growing season, when RTA was high (RTA ≥ 1.0-1.2%), the role of RTA was demonstrated. Regardless of RTA, consumers "liked" kiwifruit that had DM ≥ 16.1%, but in kiwifruit samples with RTA ≥ 1.2%, a lower DM (≥ 15.1%) is required, allowing a larger population of kiwifruit to satisfy consumers. A large number of the kiwifruit survey samples exceeded the DM ≥ 15.1%, although DM varies among vineyards and seasons, but it did change during cold storage. This lack of DM change during postharvest handling is an advantage over the current maturity index using the soluble solids concentration at harvest. Thus, DM is a reliable candidate for a quality index, but RTA should be considered. The consistent segregation of single kiwifruit during fast packaging by using non-destructive sensors using our sensory information will create a new market category and the ability to consistently market kiwifruit with high consumer acceptance. The next step will be to test if consumers would be willing to pay more to offset the costs to growers and packers for the additional expense of the investment in non-destructive sensors in the packingline, production practices, and marketing.

Is the 6.2 °Brix Soluble Solids Harvest Index Suitable for 'Hayward' Kiwifruit from High Productivity Orchard Management Systems?

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The New Zealand kiwifruit industry has used 6.2 °Brix soluble solids content (SSC) as a minimum index for harvesting 'Hayward' kiwifruit for storage for about 30 years. In that time, yield has approximately doubled and orchard management practices adopted that increase carbohydrate flow into the fruit to increase the sugar content when ripe. There has also been a trend for warmer autumn weather which may delay fruit reaching 6.2 °Brix. The selection of 6.2 °Brix was made initially as it indicated when there was an obvious increase in the rate of SSC accumulation. This increase in rate was considered to reflect the change from starch accumulation to starch breakdown, and thus represented a significant shift in the fruit physiology towards ripening. Given the changes in yield, production practices and possibly weather in recent years, the suitability of the 6.2 °Brix harvest index, and SSC accumulation in general, have been investigated with respect to current orchard management practice for high productivity. It was found that irrespective of management practice, the rate of SSC accumulation may increase steadily and continuously over the harvest period, with no obvious discontinuity in the change in rate. Fruit from high productivity orchards were likely to be harvested earlier because of their elevated SSC levels, caused by increased soluble carbohydrate import rather than starch breakdown. These 'early' fruit may have a shorter storage and shelf life because of a greater susceptibility to chilling injury. If harvested later, these fruit are more likely to have a more typical storage and shelf-life. However, if left on the vine too long, storage life may be reduced. In the absence of temperature acclimation, later harvested fruit may still be susceptible to chilling injury. Overall, while 6.2 °Brix as a harvest index is not incorrect, more attention should be paid to the actual nature and pattern of change in SSC when at 6.2 °Brix, rather than the simple numerical value.

Fruit Development and Postharvest Performance of 'Hort16A' Kiwifruit (*Actinidia chinensis*) grown in the Lazio and Emilia Romagna Regions of Italy

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Zespri® Gold Kiwifruit (*Actinidia chinensis* 'Hort16A') is a yellow-fleshed kiwifruit cultivar first introduced to the Lazio (LA) and Emilia Romagna (ER) regions of Italy in 2000. Temperatures in LA are generally warmer and soil types more acidic than in ER, but temperatures in both regions are considerably warmer and soil types heavier than in New Zealand where the cultivar was bred and first commercialized in 1993. To better understand environment-genotype interactions with this new cultivar, timing of budbreak and flowering, and climate and fruit development during the final 45-60 days before harvest were monitored in 2008 and 2009 on 11 orchards in LA and 7 orchards in ER. Fruit were harvested in October/November and degreened at 5 or 8°C, as necessary, with chilling disorders quantified after 12-16 weeks of cold storage at 0.5°C. In both years, budbreak and flowering were typically 7-10 days later in ER than in LA. Time of flesh color change from green to yellow and the rapid increase in soluble solids concentration (SSC) were also later in ER than in LA. Differences in climate between seasons appeared to affect fruit development and the chilling sensitivity of fruit during cold storage. In 2008, warm preharvest temperatures in LA appeared to delay SSC increase, with no effect on timing of color change; these fruit showed high chilling sensitivity even in fully de-greened fruit. In 2009, cold preharvest temperatures in ER appeared to delay flesh color change and thus delayed commercial harvest, but with no effect on timing of SSC increase; these fruit also showed high chilling sensitivity. These data highlight that while one set of preharvest conditions is required to accelerate degreening of the fruit, another set of conditions is needed to condition the fruit and reduce their sensitivity to chilling injury.

Relationships Between Yield and Fruit Qualitative Characteristics in *Actinidia Deliciosa* (cv Hayward)

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In the 2007-09 period, a study was carried out to evaluate the relationships between the quantity of production and the quality of fruits in the Lazio Region, which is the main Italian area for the production of kiwifruit. The investigation regarded 12 orchards of the cultivar Hayward. The yield ranged from a minimum of about 20 t/ha to a maximum of about 56 t/ha. The results showed a negative linear relationships between the yield/ha and: a) fruit dry matter percentage, b) soluble solids content, c) malic acid concentration and d) flesh firmness, all evaluated at the end of fruit storage (5 months after harvesting). Moreover, the results showed positive relationships between dry matter and carbohydrate contents and citric acid concentration. The results allow quantification of the relationships between yield and kiwifruit qualitative characteristics and indicate that, in the considered area, fruits of high quality and long storability are best obtained when yields do not exceed 30-35 t/ha.

This study was carried out under the Project "QUALKIWI" supported by Italian Mipaaf.

Highly Sensitive Ethylene Detector for Online Measurements on Biological Samples

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Kiwifruits are extremely sensitive to ethylene. As little as 5-10 ppbv ethylene will induce fruit softening, which makes them much more susceptible to several pathogens (for example Botrytis). Maintaining fruit firmness can significantly reduce pathological breakdown. Biological research on the plant hormone ethylene is often hampered by the detection limit of the available instrumentation. Preconcentration steps had to be included in the measuring scheme, making the traditional methods (gas chromatography, gas chromatography combined with mass spectrometry, or dispersive IR absorption techniques) time-consuming, not very specific and the measurements lack time resolution. Because ethylene concentrations in kiwifruits are extremely low, ethylene has to be measured with highly sensitive methods. In comparison to the conventional detection methods, optically based detectors using lasers in combination with modern spectroscopic techniques are an excellent option for sensitive monitoring of ethylene in kiwifruits. Sensor Sense developed a highly sensitive on-line laser-based ethylene detector (type ETD-300) that is two orders of magnitude more sensitive than other commercially available detectors. With its detection limit of 300 pptv (1 ppbv = 1 part per trillion volume = 1:1012) and time resolution of 5 seconds it is unique in the world. Many dynamic processes in a single plant or plant organs can now be revealed in real time without incubation periods. For many biological applications in which averaging over a one minute time scale is no problem, detection limits below the 100 pptv can be easily accessed opening new fields of investigation. In combination with a gas handling system, the ETD-300 is currently used in several research areas including plant physiology (seed germination, flower senescence, interaction with other hormones, programmed cell death, abiotic stress), microbiology (nitrogen fixation by cyanobacteria), post-harvest research (fruit ripening, plant-pathogen interaction), and environmental science.

A New Non-Destructive Fluorescence Method Applied to the Quality Control of Kiwifruit

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In order to assess fruit quality, optical methods are particularly appealing because they are non-destructive and non-contact, fast and can be applied directly in the field using portable sensors. In the present work, we used fluorescence spectroscopy to control chlorophyll concentration changes in kiwifruit. The excitation light of suitable wavelength is able to cross the woody skin of kiwifruits and reach the chlorophyll of the pericarp. This was demonstrated by measuring the chlorophyll fluorescence excitation and emission spectra of intact fruits by a spectrofluorimeter through a double arm optical fiber bundle. The chlorophyll fluorescence signal measured at two emission bands, 685 and 740 nm, is related to the chlorophyll content, due to partial reabsorption of the shorter wavelength by chlorophyll itself (Buschmann, 2007). To verify the validity of this relationship we measured 20 kiwifruits using a fluorescence sensor, Multiplex, able to detect simultaneously chlorophyll fluorescence at both red and far-red bands, at a 15 cm distance, integrating of the whole surface of the fruit larger sides. The Multiplex 2 (Mx) (FORCE-A, Orsay, France) was a hand-held battery-operated optical sensor consisting of four excitation LED sources in the

UV-A (370 nm), blue (460 nm), green (515 nm) and red (637 nm). Being the LED sources pulsed and synchronized to detection, the sensor was insensitive to ambient light and then it could also be used directly in the field. The derived chlorophyll index, CHLFRR, is defined as the ratio between the far-red and the red chlorophyll (Chl) fluorescence signals excited with red light. From the fruit side measured, pericarp samples were collected, homogenized and Chl extracted with 80% acetone. A sufficiently good correlation (r = 0.819) was found between the CHLFRR non-destructive index and the Chl*a* concentration expressed as mg/g of fresh weight. Therefore, the fluorescence method can represent a suitable non-destructive tool for fruit sorting and postharvest conservation monitoring in kiwifruits where Chl content assessment by colorimetric and/or reflectance analysis is problematic due to skin filtering properties.

Evaluation of Quality Changes during Shelf-life in Minimally Processed Kiwifruit

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The importance of fresh-cut fruit and vegetable has increased in the last years. Consumers search for ready to eat products which keep their nutritional value and quality through shelf-life. The aim of the present research was to evaluate the quality of fresh-cut 'Hayward' kiwifruit subjected to dip treatments, for 2 min, in 2% citric acid, ascorbic acid or calcium lactate. After treatments, fruit were stored at 4ºC for 9 days. Through shelf-life were evaluated the firmness, color, soluble solids content (ºBrix), antioxidant capacity by DPPH (2,2-difenil-1-picrilhidrazil), TEAC (trolox equivalent antioxidant capacity) and ORAC (oxygen radical absorbance capacity) methods, total phenols and organic acids (ascorbic and citric acids). Firmness was better kept in citric acid treatment, ºBrix was not affected, color was better preserved in calcium lactate, total phenolics and antioxidant activity in ascorbic acid, and citric and ascorbic acids in the respective treatments. In the conditions of our experiment, although citric acid treatment was the best to preserve firmness, ascorbic acid (2%) dip kept better the antioxidant properties of fresh-cut kiwifruit.

Temporal and Spatial Changes of Chlorophyll Fluorescence Characteristics of Kiwifruit (*Actinidia deliciosa*'Changan 4') stored at Room Temperature

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Chlorophyll fluorescence characteristics of kiwifruit (*Actinidia deliciosa* C. F. Liang et A. R. Ferguson. 'Changan 4') stored 0-30 d at room temperature were studied. Chlorophyll concentration in outer pericarp (OP), inner pericarp (IP) and axile placenta (AP) were determined and maximal PS II quantum yield (Fv/Fm), effective PS II quantum yield (Y(**II**)), coefficient of photochemical quenching (qP), coefficient of nonphotochemical quenching (NPQ), apparent electron transport rate (ETR) were compared. Content of chlorophyll (Chl) a, Chl b, Chl a+b and carotenoid (Car) decreased and the proportion of light-harvesting Chl to active center Chl increased as indicated by increasing Chl a/b in the same tissue zone with storage; content of the pigments reduced in the orders of OP, IP and AP while the proportion increased as indicated by decreasing Chl a/b in the same order of tissue zone in the same storage stage. Except that Y(**II**), qP and ETR were all zero in AP and its peripheral part, Fv/Fm, Y(**II**), NPQ, qP and ETR declined in the corresponding tissue zone with storage; the changing trend of these parameters were identical in OP and IP, while Fv/Fm and NPQ presented an upward trend after the first drop along the longitudinal axis from the distal end to the base of the fruit in the same storage stage

and these parameters decreased in the order of OP, IP and AP in the same stage. The results indicated that OP and IP of the fruit still had a certain degree of photochemical activity during storage.

Study of Anaerobic Metabolism of Kiwifruits Stored on ULO, LO and Regular CA

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Kiwifruits harvested at commercial ripening stage were kept at 16°C in four storage atmospheres: 0.25% O_2, 1% O_2, 2% O_2 + 5% CO_2, or air. After 19 days fruits were moved to 20°C. Ethylene and carbon dioxide production remained low during the storage time in samples stored with controlled atmosphere but at the shift to 20°C a significant increase was observed for 2% O_2 + 5% CO_2 and the lowest increase was for 0.25% O_2. During the storage pyruvate decarboxylase (PDC), alcohol dehydrogenase (ADH), and lactate dehydrogenase (LDH) activities were lower in 0.25% O_2 and control fruits. After the shift to shelf life (20°C in air) the activities increased greatly especially in the samples kept in controlled atmospheres and were continuously rising. Control fruits showed the least increase. Related metabolites showed the same pattern of enzymes activity. In parallel with this great increase, the quality parameters declined rapidly.

Innovative Non-destructive Device for Fruit Quality Assessment

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Fruit "quality" is a concept encompassing sensory and mechanical properties, nutritive values, safety and defects. Fruit quality has declined, determining consumer dissatisfaction, largely due to the wrong harvest date. In addition, quality is simply defined by parameters as sugar content, dry matter, flesh firmness assessed using traditional methods, which are affordable and fast, but do not consider other quality traits, as soluble sugars, organic acids content and health properties, which are perceived by the consumer as fruit global quality. Maturity at harvest greatly affects kiwifruit storage potential and quality at consumption: if fruit are picked too early, in fact, they undergo early softening during storage, and do not reach full flavor and aroma traits. In *Actinidia deliciosa* fruits, dry matter has been recently proposed as maturity index instead of soluble solid content. In the present work, spectroscopy in the visible/near infrared (vis/NIR) wavelength range was used for the non-destructive determination of the ripening stage of fruits in *Actinidia deliciosa* cv Hayward and to assess the optimal date of harvest. The index derived from the Absorbance Difference (AD index) between wavelengths near the chlorophyll-*a* peak was related to flesh color, and other fruit quality traits. Results obtained pointed out that, although further research is needed, this relationship could be a reliable index to assess the optimal harvest time and to forecast the storage length.

Prevention and Prediction of Kiwifruit Softening

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Softening, specifically early softening, is the main quality problem for export of Chilean kiwifruit. A four-year multifactorial project has been carried out to determine the main factors involved in softening, as well as a method that can be used for prediction and control. Different trials were performed to determine the influence of growing conditions and the most important fruit parameters on the softening susceptibility of kiwifruit cultivated in different climatic areas in Chile. Pre- and

postharvest handling techniques, including calcium applications, were also evaluated to identify their effect on quality. Fruit were harvested at 6.2-6.5% soluble solids content (except for maturity effects), and kept under the same storage conditions. Every 15 days samples were taken to determine softening (number of days elapsing until fruit reached 18 N firmness). Results indicate that softening does not depend on any particular factor but on a conjunction of growing conditions and vine management practices. Maintaining fruit firmness is assisted by management which promotes moderate vigor, adequate fruit and plant exposure to light, a reduction in the competition between fruit and vegetative growth, and high fruit Ca/N ratio. Fruit size, time of harvest, and position on the vine are also important factors. Postharvest handling is a source of difficulty for Chilean kiwifruit export that can be overcome through rigorous temperature management, controlled atmosphere, stringent control of fruit decay and ethylene control. A successful mathematical model to forecast early kiwifruit softening was developed over the last 3 years of research. Initially, three climatic groups were determined from the growing areas in Chile. In each cluster, orchard, plant and fruit variables were evaluated in nine orchards. From this data, two principal components (PC) or synthetic variables (orchard and plant component) were obtained using a PC analysis. Subsequently, a multiple lineal regression in function of the PC was used to predict period of time to reach 18 N. This model will be presented.

The Potential Benefits from Storage of 'Hort16A' Kiwifruit in Controlled Atmospheres at High Temperatures

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The storage life of 'Hort16A' kiwifruit is limited by softening and chilling disorders when stored at 1.0-1.5°C. Chilling disorders are most prevalent in fruit harvested when flesh color is >103 °hue, even when fruit have been degreened at 5°C before storage. Chilling disorders may be avoided by using higher storage temperatures, which may also reduce energy use during storage. The objective of this study was to determine whether 'Hort16A' fruit can be stored at high temperatures by using controlled atmospheres (CA) of 1.6% O_2 with 2, 5 or 10% CO_2 to retard softening and disorder development. Storing fruit harvested at 6.2 kgf when not fully degreened directly at 7°C in CA delayed softening compared with that of fruit degreened at 5°C in air and then stored at 1°C in air; firmness 4 weeks after harvest was 3.6 kgf and 1.6 kgf, respectively. However, by 12 weeks of storage, all fruit were approximately 0.6 kgf. Fruit stored at 7°C in CA still completed degreening. There was no significant difference in the softening of fruit harvested when fully degreened stored at 7°C in CA or 1°C in air. There was no significant effect of CO_2 concentration on softening, but the highest incidence of rots and disorders was in fruit held in a CA with 10% CO_2. Chilling disorders were absent in fruit stored at 7°C, but present at up to 3-5% in fruit stored at 1°C. It is concluded that it is possible to store 'Hort16A' fruit at 7°C by using CA (1.6% CO_2 with 2% CO_2) to retard softening with no detrimental effects to fruit quality compared with that of fruit stored at 1°C in air. The potential benefits are a reduction in chilling disorders and energy used during cool storage, plus for fruit that require degreening off the vine, a greater firmness retention early in storage.

Changes in Volatile Production and Sensory Quality of *Actinidia arguta* Fruit During Fruit Maturation

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Fruit of *Actinidia arguta* (Sieb. et Zucc.) Planch. ex Miq. cultivars 'Hortgem Tahi', 'Hortgem Rua', 'Hortgem Wha' and 'Hortgem Toru' were evaluated at different ripening stages corresponding to their typical shelf lives.

The volatiles released from the fruit and their sensory qualities assessed by a trained taste panel were compared with those of *A. deliciosa* 'Hayward' and *A. chinensis* 'Hort16A' fruit. Gas chromatography-mass spectrometry (GC-MS) data indicated that each species has different characteristic volatiles. Large amounts of straight chain aldehydes and esters were the dominant volatiles detected during commercial shelf life for *A. arguta* fruit. As in 'Hayward' fruit, the total percentages of (E)-2-hexenal and hexanal, which impart green characteristics, decreased as the fruit softened. Butanoates (fruity) detected in the fruit increased as fruit firmness decreased. However, in the *A. arguta* fruit, significantly higher levels of terpenes were detected and the amounts of terpenes in the fruit increased with fruit softening. Study of the volatiles in eating-ripe 'Hortgem Tahi' fruit also indicated that the increase in the volatile amounts depended on the increase in ethylene as well as the decrease in fruit firmness. With fruit softening, sensory perception of acidity decreased but typical kiwifruit odor and flavor intensity (ethyl butanoate) increased. More tropical aroma and a slightly bitter skin taste were noted by panelists as fruit softened.

Could Pre-Harvest Applications of 1-MCP Improve Postharvest Life of Hayward Kiwifruit?

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One of the main problems during postharvest in kiwifruit is flesh softening, since part of this process is coordinated by ethylene. Therefore, many postharvest strategies have been developed in order to reduce fruit softening, including early harvest, controlled/modified atmosphere storage, ethylene scrubbers and 1-MCP (SmartFresh^{SM}) applications after harvest, with Smartfresh being extensively used in the last 3 years in Chile. Under Chilean growing conditions the harvest window is quite long depending on the growing area, going from March to May which would be affecting the postharvest behavior in quality attributes, including firmness. During the last 3 years, a new formulation of 1-MCP has been developed for applying this molecule in preharvest (Harvista^{TM} Technology), being the objective of this study to evaluate the effect of this molecule at harvest and during postharvest of kiwifruit. For the trials we considered two application times before harvest and two harvest opportunities based on maturity. At harvest no differences were observed for all the parameters evaluated. But for harvest time, an effect in fruit softening was observed during cold storage showing all the fruits applied with 1-MCP a higher firmness compared to control fruits, with this effect more evident in the second harvest. This effect could be explained by the effect of 1-MCP in ethylene production and respiration rate, where lower rates in both parameters were measured in kiwifruits applied with 1-MCP. In other attributes such as total soluble solids, titratable acidity and physiological disorders no major differences were observed.

Beneficial Effects of Pre-Commercial Application of SmartFresh^{SM} (1-MCP) on Texture Preservation and Reduced Weight Losses Associated with Low Ethylene Concentration in Storage Rooms of 'Hayward' Kiwifruit

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Pre-commercial applications of SmartFresh^{SM} (SF) were carried out in two storage units, located in the main kiwifruit growing areas of Pieria (2008) and Kavala (2009) prefectures of North Greece to determine the commercial benefits of the new technology in the Greek kiwifruit industry. The aim of this study was to evaluate under commercial storage conditions of kiwifruit whether SF shows the same effects found in previous pilot studies to extend the marketing period and to determine the

commercial benefits of the application of SF technology. In the Kavala unit, under the commercial conditions in the storage room the SF treated kiwifruit showed lower values of ethylene concentration (m.a. 0.012 ppm) than the room with the control fruit (m.a. 0.041 ppm). The study showed that the SF treated fruit remained firmer versus the control fruit, during storage and shelf life and consequently had an extended marketing period for wholesale and retail operations. However, during shelf life (Pieria-2008) the SF treated fruit recovered softening and by the end of the storage the fruit developed the melting flesh texture of the kiwifruit edible quality. In reference to the changes of soluble solid content (SSC) the SF treated fruit reached, with no delay, by the end of the storage season the highest SSC, with no difference with the control fruit. Similar results with differential effects of SF on firmness and SSC were found also in the Kavala unit. During the storage period the SF treated fruit showed, in both units, reduced values of weight losses (about 50%) in comparison with the control fruit. This was attributed to the lower rate of the respiration of the SF treated fruit. If we consider that weight losses are quantitative losses (loss of salable weight) the above finding gives an important advantage in favor of SmartFresh technology.

POSTERS

Postharvest Application of 1-methylcyclopropene (1-MCP) extends Shelf life of 'Hayward' kiwifruit

C. M. Cantin, D. Holcroft and C. H. Crisosto

The role of postharvest application of 1-Methylcyclopropene (1- MCP) in the softening of 'Hayward' kiwifruit under different cold storage conditions was investigated. 1-MCP treated fruit (0.0, 0.5, 1.0 µL L-1) were kept in cold storage (1°C) up to 4 months before ripening. Different 1-MCP application times were also tested in this trial (12 and 24 h). Effect of 1- MCP under free ethylene atmosphere and under ethylene contaminated atmosphere during storage was investigated. Under both conditions, 1-MCP treatment significantly delayed the rate of fruit softening during cold storage. Firmness out of cold storage was significantly increased by 1-MCP treatments. Moreover, the number of days of shelf life at 20°C (after 4 months of cold storage at 1°C) needed by 'Hayward' kiwifruit to reach a flesh firmness ≤ 10 N was significantly increased by 1-MCP postharvest treatment. Our results show that the protocol of 1-MCP appliance to follow to obtain the best results on extending shelf life of kiwifruit depends not only on the length of the cold storage period but also on if the atmosphere where the kiwifruit is being stored is free or contaminated with ethylene.

Evaluation of a Non-destructive Dry Matter Sensor for Kiwifruit

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In this work we studied the relationship between kiwifruit dry matter (DW) measured using the destructive method with a fruit dehydrator (Nesco/American Harvest®, Wisconsin USA) and a non-destructive Kiwi meter sensor (Turoni Inc., Forli, Italy). This was an approach to develop a reliable non-destructive method to predict harvest and postharvest quality based on dry matter. There was a significant, but low correlation between DM determined non-destructively using the Kiwi meter and destructively using the fruit dehydrator (industry standard). Classification models with discriminant analysis were used to segregate kiwifruit into groups according to DM. Using this statistical approach rather than the relationship between the two methods, kiwifruit were consistently segregated into two DM groups, but classification into three groups yielded lower scores. These results indicate that

the Kiwi meter is a reliable and fast sensor to segregate kiwifruit according to their DM content that could be considered as a consumer quality index at harvest and/or postharvest index. Further work on the optimization of this non-destructive sensor as a tool to define consumer kiwifruit quality is being carried out by our group.

FUTURE DATES

Upcoming events are posted on the Postharvest Calendar at the UC Agriculture and Natural Resources, website at: http://ucce.ucdavis.edu/calendar/calmain.cfm?calowner=5423&group=w5423&keyword=&ranger=3650&calcat=0&specific=&waste=yes

Information about upcoming events can also be found on the Postharvest Technology Research and Information Center website at http://postharvest.ucdavis.edu/