PRODUCTION SYSTEMS OF KIWIFRUIT IN EUROPE

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Keywords: acreage, new cultivar, pruning, pollination, bioregulators

Abstract

Kiwifruit acreage and production are increasing. The establishment of new orchards and especially the entrance of China in the kiwifruit world market is substantially modifying the scenario. As a general statement, it has to be considered that the kiwifruit market is characterized by a high degree of international competition and fruit quality, now more than before, may be the key to retaining, or even increasing, market share and opening new markets. In addition new cultivars have been proposed in the last years and this also contributed to change the kiwifruit scenario. These new cultivars required distinct cultural management than Hayward. Pruning and the light/vine relationship, pollination, nutrition, irrigation, use of 'dormancy-breaking agents' and bioregulators showed to be important factors for achieving fruit quality in Hayward while few information are still available on these new cultivars. Some results and consideration on these aspects are here reported and discussed.

1. Introduction

Italy is the first producing country of Kiwifruit in Europe and second in the world considering China as far as the acreage and the total production is concerned (Figure 1 and 2). In Europe also Greece and France produce interesting amount of kiwifruit while in the other hemisphere New Zealand and Chile are the most representative countries. China, the country of origin of kiwifruit, is reported to be the country with the higher acreage of kiwifruit planted. Kiwifruit industry in China is reported to increase very rapidly (Huang and Ferguson, 2002) and, although the varieties cultivated are quite different from Hayward and Zespri Gold, it might represent in the future a strong competitor on the Asian and European markets as well. In fact Hayward orchards have been planted in these years in China and cultural management are rapidly improving. In addition China can count on a unique natural germoplasm repository and might also have the possibility to breed new cultivars of different species than *A. deliciosa* or *chinensis* (red flesh variety) suitable to be cultivated in different countries (Wang et alii, 2003; Montefiori et alii, 2003).

Actually Europe represents one of the most important market for all the producing countries around the world. Europe in general and Italy in particular has scarce and very expensive labor. The competition with other producing countries can not be based on the cost reduction but only on the possibility to enhance the quality of the fruits marketed. Kiwifruit orchard management relies on several techniques and aspects which are fundamental to achieve and maintain high fruit yields and quality standards. Pruning, pollination, nutrition and, more recently, the use of bioregulators can be considered fundamental factors to take into consideration. It has also to be considered that recently new cultivars have been introduced in Europe in general and in Italy in particular (Table 1 and Table 2). At the moment few information are available on the best cultural management to be adopted for these cultivars. In some cases the solutions used for

Hayward have been just translated to these new cultivars while in other situations new orchard typologies and cultural management have been specifically adopted for them.

Below are listed the main cultural techniques adopted for the Hayward and the main differences proposed for some of the new cultivars. It has also to be underlined that very little on the best cultural management for these cultivars has been published and that most of the information are from the different Consortia holding the multiplication and diffusion rights of the varieties.

2. Pruning

Several studies have been carried out on this topic in the ‘70-’80 and thereafter pruning researches have been abandoned to some extent. This fundamental aspect should be taken again into consideration considering that new varieties and new orchard typologies have been proposed. Pruning is recognized as a fundamental operation performed yearly in winter and summer. It allows to balance the reproductive/vegetative growth ratio, to ensure the renewal of bearing canes and to keep the vine canopy within the allocated space. In Hayward, fruit thinning has a strong influence on fruit size and quality. This technique is now a routine operation, while it was not in the first year of introduction of the specie in Europe since all the fruits were marketed almost independently from their quality. The main research findings behind the choice of specific techniques adapted to Hayward and to the new cultivar and orchard type would be valuable.

2.1. Training systems and planting distances

As far as Hayward is concerned, Pergola and T-bar were the training systems originally adopted and are still the most widely used. The former is usually employed in the warmer areas and the latter in the cooler ones. Planting density ranges around 400-600 vines/ha for pergola and up to 900-1000 vines/ha for T-bar (Costa et alii, 1990; Costa et alii, 1993a; Costa , 1999). The higher number of vines was designed to enhance yields in the initial years of orchard establishment. (Testolin et alii, 1987; Costa et alii, 1991; Costa and Testolin, 1995). In the ’80 other systems have been proposed in given areas, such as the “V” or Tatura, spindle and Peyracchia (Costa et alii, 1991; Costa et alii, 1995), but they have either been abandoned, because they were not justified by yield or fruit quality, or have found only limited application in certain districts (Costa et alii, 1996a).

Actually new orchards typologies and training systems are proposed for some of the new cultivars (i.e. Summerkiwi 3375 and 4605). These new typologies and training systems mainly refer to a modified “Geneva double curtain” (GDC) type. The planting density used for this system range from 1500 up to 2000 vines/ha. The main goal is to begin to produce as early as possible. This system is not completely evaluated, the first orchards are 2-3 years old; however it has to be said that this system does not only consider a higher number of vines/ha but require vigorous vine for planting, and a specific pruning and nutrition (Dal Pane, 2002).

Vines can be obtained by cutting or by micropropagation. The training system is realized as following;

1) The leader shoot of the vine is pruned at 70-100 cm height;
2) In the Spring the most vigorous shoot is selected and allowed to grow up the upper wire (Figure 3a);

3) A different number of pruning is performed on the leader shoot depending upon the method of propagation used to obtain the vines. When vines are “from cutting” shoot are pruned at 1.50 m height to have strong leader. If vines are “from micropropagation” pruning is performed 3 times in the nursery and the last in the field at 1.60 m to obtain strong leader. Only one leader is selected and fixed to the upper wire;
4) At the end of October the vines are bent alternatively to right and left to form a double curtain system. Shoots are fixed to a wire 2.0 m high and placed 75 cm from the center row to form two permanent cordons placed in the direction of the dominant wind (Figure 3b);
5) In the following Spring, all the shoots originating from the curve and the first 20 cm of the permanent cordon are eliminated to avoid possible competition with the permanent cordon (Figure 3c,d);
6) When shoots reached 20 cm length are pruned back to 2 - 3 cm to eliminate the risk of wind breakage and to allow new shoot formation;
7) In the second year, summer pruning is performed to eliminate all the vigorous shoots which might compete with the permanent cordon;
8) Winter pruning instead is performed to eliminate all the vigorous shoot originated in the upper part of the cordon as well as those growing inside the canopy in the row direction. Only the moderate vigor canes are maintained and spaced 20 cm apart one from each other.

2.2. Bud-load, cane length and cane distribution on vines

Bud-load has also proved to be an important aspect for Hayward. Several studies carried out on T-bar orchards have indicated that 150-200.000 buds/ha represented an optimum bud-load for good fruit yield and quality. Increasing these values while could led to a yield increase determines contemporarily a drop in average fruit weight.

Cane length and distribution on vines is also related to bud-break rate, bud fertility and fruit growth. Proper distribution of the canes on the vines enhances light and air penetration, thereby reducing susceptibility to diseases, especially *Botrytis*. Evidence indicates that there should be about 15 buds per cane, fewer do not allow satisfactory bud-break rates since the basal buds on a cane are generally non-bearing, while more causes a general drop in bud fertility.

Does the new cultivars perform as Hayward as related to the bud-load?

The orchards are still young and no clear results are available. Per sure the higher number of vines lead to a higher number of buds.

For instance Zespri Gold is trained as pergola and T-bar at a planting density of 500 vines/ha. More recently higher planting densities (up to 900-1000 vines/ha) have been proposed. The bud-break and especially fertility is higher than Hayward and it has to be controlled to bear fruit of good size and weight. For instance the number of canes left with the winter pruning is reduced with subsequent pruning beginning when the new vegetation is 10-15 cm long leaving 1 canes every 3 in order to have a cane spaced 40 cm apart from each other. Pruning is essential in reducing the number of canes especially when fruit load is very high (Martin et alii, 2001).

As far as the Summerkiwi varieties are concerned, the Consortium suggest mainly GDC system (up to 2000 vines/ha). As described before the training system require high quality scions for planting and a specific pruning technique to reach the proper vegetative and reproductive performance. The high density planted orchards of Summer kiwi easily reach 200-250.000 bud/ha. In addition the first observations available indicated that the bud-break percentage is higher than Hayward and this might be in the future require intensive fruit thinning or pruning performed in winter and summer to control excessive growth or fruit load. The adopted pruning technique however, allowed only a proper number of few short branches on the cordon to eliminate competition among the branches and the fruits. Up to now the young orchard did not present any major problems in term of yield and average fruit weight (Dal Pane, 2002).

As far as Jintao ("Kiwi Gold") is concerned, the Consortium "Kiwi Gold" suggest to use a standard T-bar for this cultivar with a planting density of 1400-1500 vines/ha. Few orchards have been established with a GDC system and a planting density of 1800-2000 vines/ha. Jintao is less vigorous than Hayward and it is characterized by a higher fertility. Shoots are short and less susceptible to be wind broken. Average fruit weight range between 80 and 95 g and in order to enhance it pruning to reduce the number of canes and fruit thinning are important. The first observations pointed out that in order to enhance fruit weight canes of a size of 10-12 mm diameter must be selected. In Italy where the most of the acreage is, the orchards have been just established and only the production from very young vines are available.

2.3. Light/vine relationship

The cultural management chosen must allow the better light penetration into the vine canopy and having in mind the importance of the light/vine relationship. In Hayward, several contributions on light/vine relationship clearly show the importance of intercepted light to vine bud-break and yield (Table 3). It has also been demonstrated that light influences fruit quality: light-exposed fruits were characterized by higher SSC and flesh firmness and greener fruit flesh than shaded fruit which also had lower contents of starch and sugars but higher contents of acids (Table 4).

In Hayward to ensure better light interception, rows should be N-S oriented and canes should be spaced well apart from each other depending upon the bud-break percentage which does characterize each cultivar. As a consequence canopy development should be checked since bud-break and bud fertility change from year to year, being strongly dependent on climatic conditions. Several study carried out on Hayward showed that leaf density and its ability to intercept light that penetrates the canopy are expressed by the leaf area index (LAI). Canopy must be formed in the shortest time possible and be characterized by LAI values of around 3. Higher LAI values cause shading of large parts of the canopy, thereby negatively affecting yield and fruit quality (Smith et alii, 1994). In addition, specific studies carried out in New Zealand have shown that in a modified T-bar system, 70 % of the leaves but only 30% of the fruits were usually found in the zone close to the permanent cordon while exactly the opposite was found at the distal part of the bearing canes (Smith and Buwalda, 1994). It was also found that variations of fruit quality within the canopy of a single vine were substantial. Fruit with superior characteristics were found in greater number in the denser part of the canopy, close to the permanent cordon, whereas fruit with fewer of the required attributes were found at the extremities of the canopy, where the LAI was low. These findings have led to practical indications, e.g., that canes should be kept to a certain length and a uniform canopy LAI has to be achieved in order to reduce as much as possible the high variability of fruits on the same vine (Smith et alii, 1997).

In the new cultivar these aspects have not fully investigated yet. However the results of some preliminary studies pointed out the importance of light in these cultivar as well. For instance, as far as the flesh color is concerned, a specific trial carried out to study the relationship between light and flesh color of Hayward and Zespri Gold showed that fruits exposed to the light showed a higher color intensity than fruits shaded for different span of time before harvest (Montefiori, 2004). It has to be noticed that this aspect is becoming crucial as far as the fruit quality is concern. In fact Hayward fruits characterized by a bright green color are attractive and appreciated by the consumers while pale green-yellow color fruits are not. This aspect is also important for the *A. chinensis* selections: in fact the color of the flesh of "Hort16A" and "Jintao" must be "gold", so the name "Zespri Gold" and "Kiwi Gold".

2.4. Summer pruning

Contradictory indications are reported as far as summer pruning is concerned. While it is clear that summer pruning may enable better light penetration through the canopy; Snelgar et alii (1986) clearly demonstrated that, in general, neither the severity or the timing of summer pruning induced better fruit weight while significant leaf-to-fruit ratio variations may adversely affect fruit size (Table 5).

However a recent trial concerning a comparison between standard pruning versus a pruning type where all the shoots present on the permanent cordon were constantly removed, lead to a better vegetative and reproductive performance: in fact yield and average fruit weight were increased as well as the soluble solids content of the fruit of the summer pruned plants as compared to the non-pruned ones (Table 6).

Again , summer pruning should also considered as a toll to reduce the susceptibility of the fruit to *Botrytis.* A pluriannual trial carried out to verify the influence of summer pruning on *Botrytis* susceptibility showed that the more intense is the pruning performed during the season the lower is the susceptibility to the disease. All the vigorous shoots originating from the cordon were constantly eliminated and the pruning was performed up to 6 times/year in some years: as an average fruits of the summer pruned vines reached a reduction of about 40% of the infected fruits as compared to control (Table 7).

2.5 Reflecting mulch

Another possibility to increase light availability through the canopy in the kiwifruit orchard may be represented by the use of reflecting mulch. This may determine an increase in fruit quality and better bud quality for the following year, as it has been shown by previous work carried out under New Zealand climatic conditions (Thorp et alii, 2001) and in Italy (Costa et alii, 2002). Results obtained using a special reflective mulch patented in New Zealand (Extenday®) although preliminary, confirm the yield increase induced by the reflecting ground cover, as well on soluble solids content as found in other species (Thorp et alii, 2001). Fruit soluble solids content and other parameters were as a trend ameliorated by the reflective mulch, although these changes could be on the one side ascribed to the gas-exchange increase, but on the other to an advanced maturity stage, which might have been induced by the increased available light, as occurred in other species (Richardson et alii, 1993; Thorp et alii, 2001). In our trial, the max CO_2 assimilation was increased by almost 25% and such an increase could have led to higher sugar accumulation in the fruit and as a consequence to a better quality. Our results of increased assimilation and transpiration in response to the mulch agree with similar findings obtained by Green et alii (1995), who estimated the gas exchanges based on measurements of the light intercepted by an apple tree over reflective mulching.

2.6. Fruit thinning

Fruit thinning has become a routine operation, usually performed when bud-fertility reaches high values as it normally occur in climatic areas characterized by cold winter which enhance bud fertility. It is generally carried out at blooming time or just after fruit set, and consists of the elimination of all the lateral fruits of the inflorescence and even of terminal fruits when their number per shoot exceeds an average of four . In table 9 are reported the results of an experiments devoted to evaluate the efficacy of fruit thinning as affected by different bud-load. It is evident the positive effect of fruit thinning in each treatment considered.

2.7. Old orchard renewal

Some 15-20 years old orchards showed a significant reduction of the yield/ha. This fact, which did not find an exhaustive explanation up to now, might be also related by "wood decay", a disease that has been signaled in Italy (Di Marco et alii, 2003) as well in France (Hennion et alii, 2001) and in Greece. Since fungicide application did not solve the problem, trials concerning the total renewal of the canopy through pruning technique have been recently carried out. Vines trunk is cut below the rotted and discolored wood, up to obtaining a visually healthy wood. Orchard planted in 1986 and cut back in 1998, gave 70% of the yield in 1999 and reach the yield of the healthy vine in the 2000 (about 40 t/ha) (Table 10).

3. Pollination

Since the kiwifruit is a dioecious species, pollination of pistillate cultivars by staminate cultivars is essential for cropping. Many researches has been expended on the staminate:pistillate cultivar ratio and their distribution in the orchard. The main problems in the pollination process are concerned not so much with the amount of pollen produced (0.5 to 2.7 million pollen grains/flower (Gonzales et alii, 1994)) as with its transport from the staminate to the pistillate cultivars and with the male genotypes used for pollination.

3.1. Pollination vectors

Bees, wind and so-called 'artificial pollination' methods are currently used. Pollen is transferred from male to female flowers both by wind (Intoppa and Piazza, 1990) and by insects (Goodwin, 1987). While the relative importance of the two vectors has been debated for the last decade or so (Craig and Stewart, 1988), it has been established that wind is responsible for the transport of hundreds of pollen grains allowing almost all flowers to be set (Costa et alii, 1993). However, differences have been observed, not in the percentages of fruit set, but in fruit size. Experiments carried out in various growing areas have shown that wind is responsible for an average 60-70 g of fruit weight (Costa et alii, 1993); in other trials that average has reached even higher values (Intoppa and Piazza, 1990). However, the results can be considered not fully satisfactory and far from those attainable with hand pollination (Vaissiere et alii, 1992).

Bees may offer better results (Donovan and Read, 1991), and honeybees are the most important species for pollination (Goodwin, 1987) (Table 11). However, when hives are introduced in the orchard the bee health have to be controlled. In some years some diseases (*Varroa*) severely affected the number of bees/hive reducing the efficacy of cross pollination. Table 12 lists reported recommendations on the correct use of honeybees in the orchard.

Recently in Italy it has been proposed to introduce in the orchard other species as *Osmia* sp. which showed to visit kiwifruit flowers and to be a specie more adaptable to different environmental condition than *Apis mellifera* (Pinzauti, 2000).

3.2. Male distribution in the orchard

Pollinizers should be located in each row and as close as possible to the 'Hayward' vine since it has been observed that the greater the distance to the pollen source, the lower the yield and average fruit weight. To this end, it has been advocated that pergola-trained orchards in New Zealand should have one row of 'Hayward' followed by one male row. The male has to be pruned in a particular way, called 'narrow strip', i.e., it leaves a very narrow strip all along the row so that the remaining space can be occupied by the female vine so as to provide as wide as possible a fruiting area. In the T-bar system, the standard female-to-male ratio is 7:1. This ratio, which has to be retained spatially to achieve satisfactory yields, can be converted to a ratio of 3.5:0.5 female:male cordon so as to have a male closer to each female vines. This allows the same proportions of the canopy dedicated to female and male vines but the source of pollen is closer to the female vine.

Recently a new male distribution has been proposed for some of the new orchard established with some of the new cultivar (i.e. Summerkiwi and Jintao). Staminate vines are trained at a lower wire (110 cm height) placed at the center of the row. Male vines should form a continuos cordon for all the row length. Each male vine should be allowed to grow for 8 meters (figure 6).

3.3. Choice of pollenizer

A good pollenizer should coincide in flowering with the female and should have good pollen germination and good fruit setting ability. Several of the males selected from the world's main growing areas (McNeilage et alii, 1991; Testolin et alii; 1995, Testolin and Costa, 1994) have pollen germination rates similar to those of 'Matua', although they usually bloom earlier than 'Hayward'. Although in New Zealand 'Chieftain' is the male selected for that environment and is the suggested pollinizer for new plantings, a new male named 'Autari' has been selected for Italy's climatic conditions. It appears to have the same good characteristics as 'Matua' while differing from it in having better coincidence in flowering with 'Hayward' and in its petals remaining white even at petal fall (Testolin et alii, 1995) .

As far as the new cultivar are concerned, each Consortium have suggested the best pollinizers for each cultivar. Results are still under evaluation.

3.4. Artificial or assisted pollination

Assisted pollination, whether by hand or using pollen spraying devices in a liquid or dry form, can offer interesting results, although it has to be said that the results are largely governed by how the operation is managed and how much time is allowed to do it properly. When orchards are small, no particular problems arise, but if the orchard comprises several hectares or more, artificial pollination can fail since pollination may not be performed at the receptive stage for all flowers. In general, artificial pollination is complementary to wind or bee pollination, and should be performed when climatic conditions are adverse to natural vectors or when the number of male vines in the orchard is deemed insufficient.

Recently several equipment devices have been proposed in Europe in general and Italy in particular. These devices can be portable or carried out by the tractor. These pollen distributors are generally used at the end of the blooming period after a natural pollination occurred. The pollen can be distributed in a mixture with *Licopodium* pollen (dry method) or can be distributed using liquid solution which guarantee the vitality of the pollen during all the distribution span of time (wet method). The first method is more effective when the humidity is naturally high (i.e. in the morning) while the second can be used for all the day long. Different systems are proposed depending upon orchard dimension and climatic conditions.

"Portable system" –speedy: used for small orchard (1 or 2 hectares at the most). Pollen distribution may occur at 80 and at 100% open flower using an amount of pollen of 200 up to 500 g/hectare. The application may require 4, 6 hours/hectare. The kiwifruit pollen is mixed with *Licopodium* pollen in a 1:1 ratio (dry method) and it is performed preferably performed during the morning .

"System carried out by the tractor (Figure 7): it can be used in orchard of a high number of hectare since the device carried out by the tractor require 1 or 2 hours to pollinate 1 hectare. Some equipment (Spider) may provide a wetting of the flower trough a sprayer by nozzles just before the pollen is applied. The pollen is supply in the same mixture with *Licopodium*/kiwifruit 1:1 ratio (Figure 7).

4. Chemicals and bioregulators

The chemicals and bioregulators most used in kiwifruit are the 'dormancy-breaking agents' and the compounds capable of enhancing fruit quality (size and sugar content). Warm growing districts may be hampered by unsatisfactory bud-break and bud fertility, a response that could be related to local climatic traits and to mild winter temperatures that do not meet chilling requirements. Inadequate chilling can be countered by using such dormancy-breaking agents as hydrogen cyanamide (Dormex or Hi-Cane) and other chemicals (Costa et alii, 1995b; Vizzotto et alii, 1996a and b). The main effects induced by Dormex are an increase in bud-break and bud fertility, a synchronization of flowering of male and female vines and a reduction in the duration of flowering (Henzell and Briscoe, 1986; Henzell et alii, 1991) (Table 13). Dormex is usually applied at concentrations between 2 and 5% 40-50 days before expected bud-break. In the cooler areas where the chilling requirements is generally satisfied the use of Dormex can cause a thinning of the lateral flower of the inflorescence (Stowell and Montefiori, 2002). The reduction can be interesting allowing to save more than the 50% of the time required to perform the fruit thinning (Vizzotto et alii, 1996 a, b; Montefiori et alii, 2003). Dormex is also applied on the cultivar Zespri Gold. The results of trials carried out in New Zealand pointed out much higher concentrations of those normally used in Hayward (McPherson et alii, 2003).

Other chemicals (nutrient mixtures) and bioregulators have recently been used to enhance fruit growth and size. It has to be said that these substances represent an interesting tool to ameliorate fruit morphogenesis and fruit quality but its use has to be considered as complementary to the genetic and agronomic tools. In fact these substances are not able to correct important mistakes that have been determined (i.e. lack of pollination, etc). It has also to be said that the attitude versus these compounds changes quite recently. The use of some of these chemicals is not allowed in Europe and there is an attitude to discourage the use of these substances because from the marketing point of view it may induce the consumers to think that big size fruit have been obtained mainly with chemical methods.

Several of these substances are still under research: the most effective are reported in the following list: (Costa et alii, 2001):

- **Forclorfenuron**, CPPU (named Sitofex or Caplit, Degussa, Germany, and Kyowa, Hakko, Japan) is a diphenylurea derivative characterized by a strong cytokinin-like activity capable of increasing average fruit weight and yield and of enhancing fruit maturity at harvest (Lawes et alii, 1991; Patterson et alii, 1993; Costa et alii, 1996; 1997). The concentration ranges between 5 and 20 ppm and the optimum application time is about 2-3 weeks after full bloom. The effect is to some extent related to the concentration (Table 14, Figure 8 and 9) although it must be considered that the concentration increase may cause collateral effect. Some researches pointed out the possibility to positively affect fruit quality determining an increase in soluble solid content (de Lotter, 1991; Famiani et alii, 1995). As a final remark, CPPU has proven a useful tool to improve fruiting performance, although its application is recommended only in orchards where proper management and pollination techniques are employed. It is not allowed in Italy on kiwifruit.
- - **Benefit PZ**, is a biostimulant of Valagro, Italy. It contains nucleic acids, vitamins, proteins and free aminoacids. It is used on several fruit species as well as Hayward and Zespri Gold. The name of the chemical in New Zealand is "Benefit gold". It is used at concentration ranging from 4 or 5 kg/ha at two/three weeks after full bloom followed by three or more applications at 20 days interval. The chemical induced a higher average fruit weight and a better distribution in the commercial fruit grading (Figure 10). No particular effect have been detected on fruit quality traits (Table 15).
- - **Phytagro**, is a chemical of Intrachem Italia. It contains growth substances from natural extraction (GA_3 700 ppm; IAA 70ppm; zeatin 1000ppm and vitamin 850ppb). It is used at the concentration of 100 ml/100 litres of solution at three weeks after full bloom. The chemical showed to positively affect fruit average weight and marketable distribution (Figure 11). No significant differences from control were observed after Phytagro application.
- **Maxim,** it is a formulate which contains auxin. It is commercialised by Gobbi, Italy on citrus. Some recent research showed the capability of this chemical to positively affect fruit size and marketable grading distribution (Table 16). It is not allowed in Italy on kiwifruit.

4. Final remarks

Consumers are demanding fruit quality enhancement and all the cultural management techniques able to enhance it should be studied and improved. Hayward still represent the most important variety all over the world and fruit quality may be the key to retaining, or even increasing, market share and opening new markets. The new cultivar recently introduced in some European markets must have a quality comparable to Hayward and the dedicated cultural management techniques must also be able to maintain a high quality standard fruits.

As a consequence the choice of the cultural management and of the pollination technique must allow to reach the best vegetative/reproductive performance ratio and allow high fruit quality standard for each chosen cultivar and environmental conditions.

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AKNOWLEDGEMENTS
Research supported by a MURST 40% grant. Fruit quality and microclimate conditions (temperature and light) in different positions in the canopy of kiwifruit (*Actinidia deliciosa*).

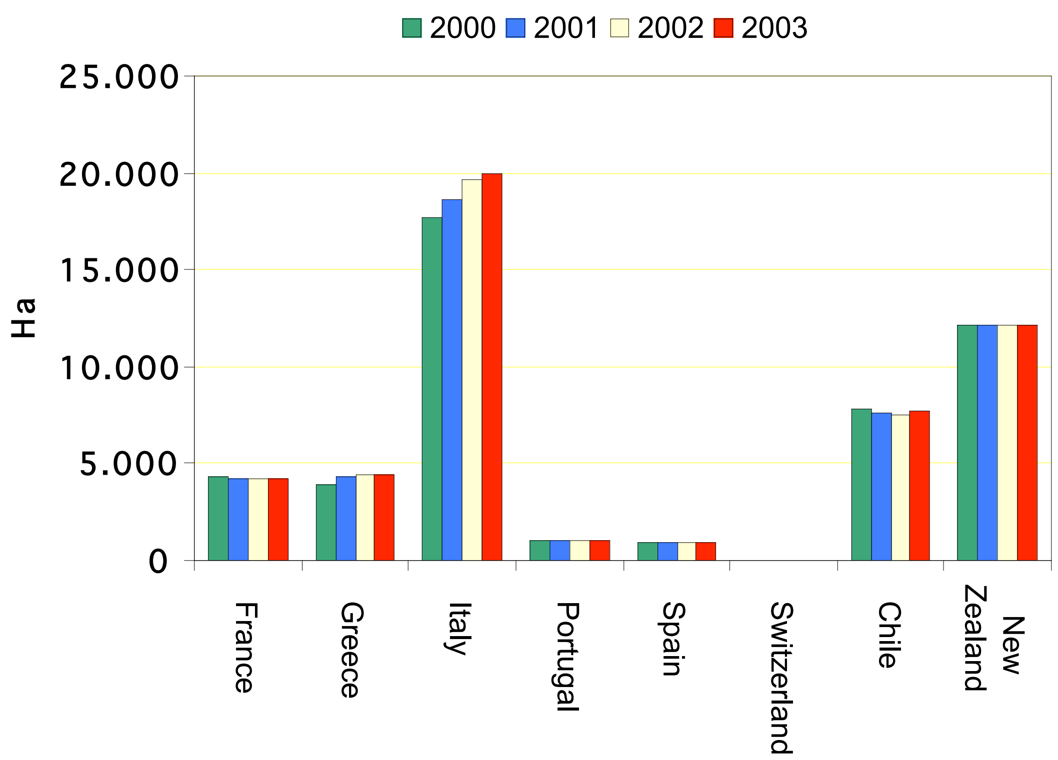

Figure 1- Kiwifruit acreage in the main producing countries (Source:FAO)

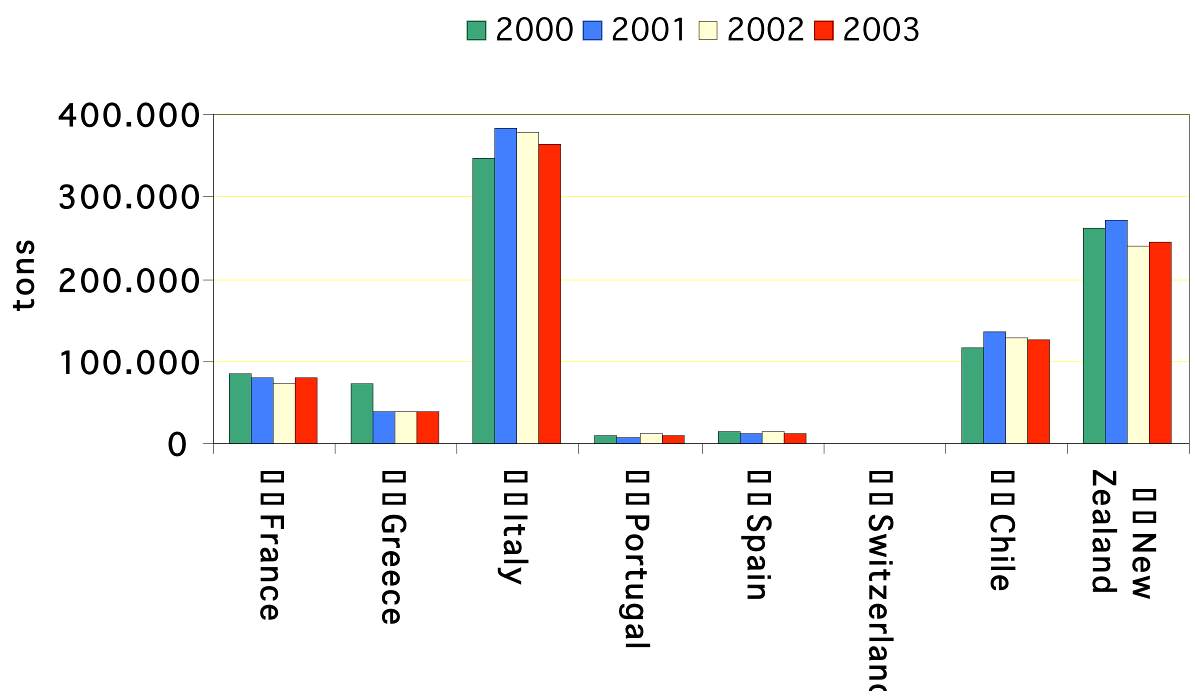

Figure 2- Kiwifruit yield in the main producing countries

Figure 3. A) A strong shoot is allowed to grow up to the upper wire; b) a double curtain is formed bending the vines alternatively at left and right on the row; c,d) vines before and after winter pruning. The upper part of the cordon is totally exposed to the light and the canes which will carry the future production are spaced a part on the permanent cordon. (Courtesy of Dal Pane Nursery)

Figure 4- Extenday reflective mulch

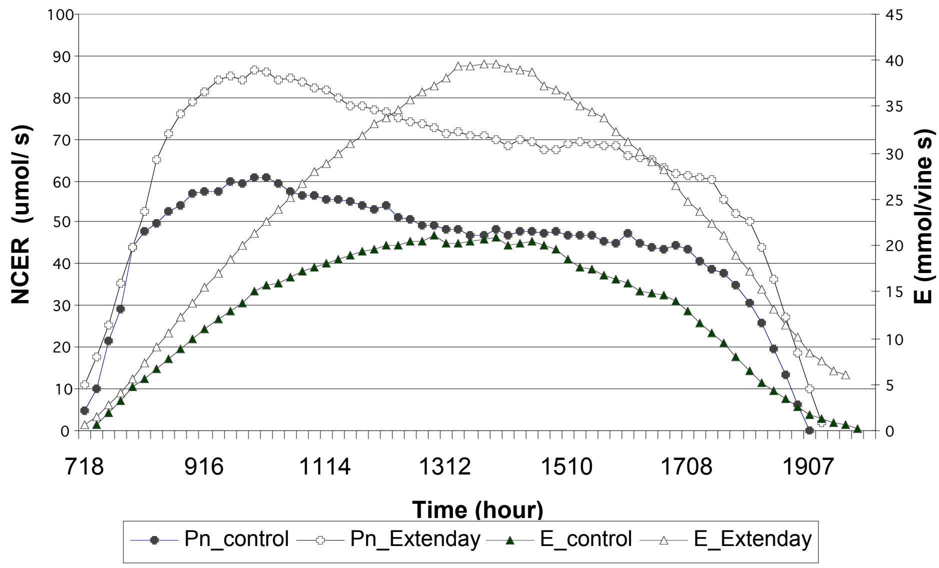

Figure 5 –Gas-exchange as affected by Extenday reflective mulch

Figure 6- The male vine is trained in a cordon that runs below the pistillate canopy for all the lenght of the row

Figure 7- Different equipments to perform “assisted pollination”. Upper-left:pollinator system of Bovo; upper-right: Spider, pollinator device of Dall’Agata; lower part: other pollinator devices used in North-Italy

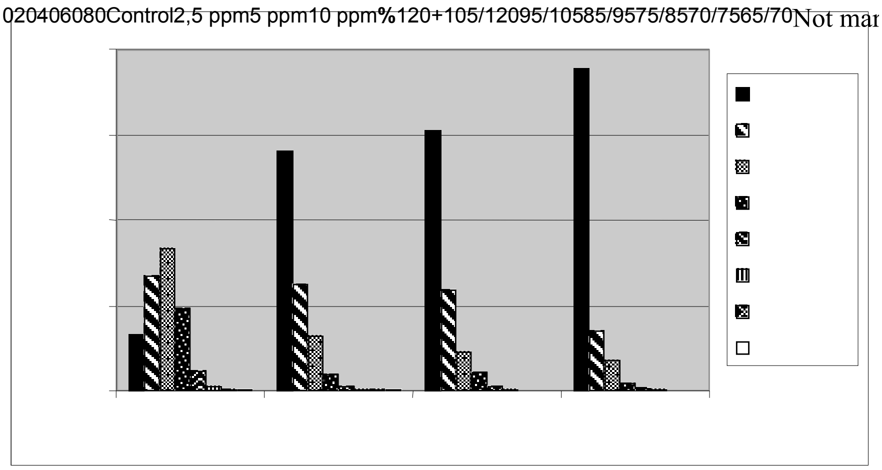

Figure 8-Fruit distribution in marketable classes as affected by CPPU concentration.

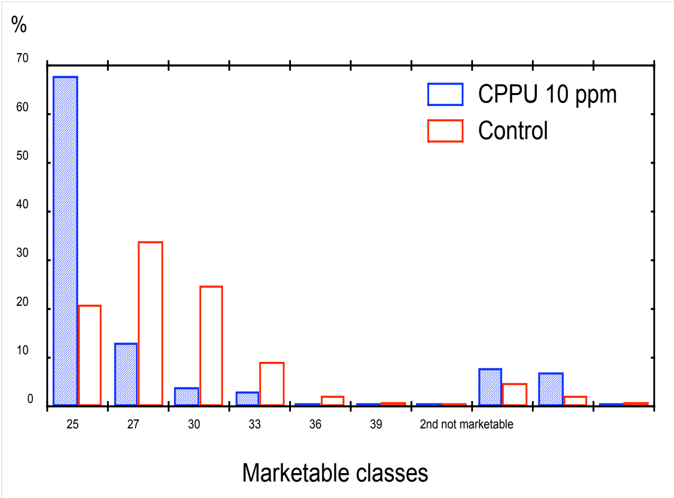

Figure 9- Fruit distribution in marketable classes as affected by CPPU application

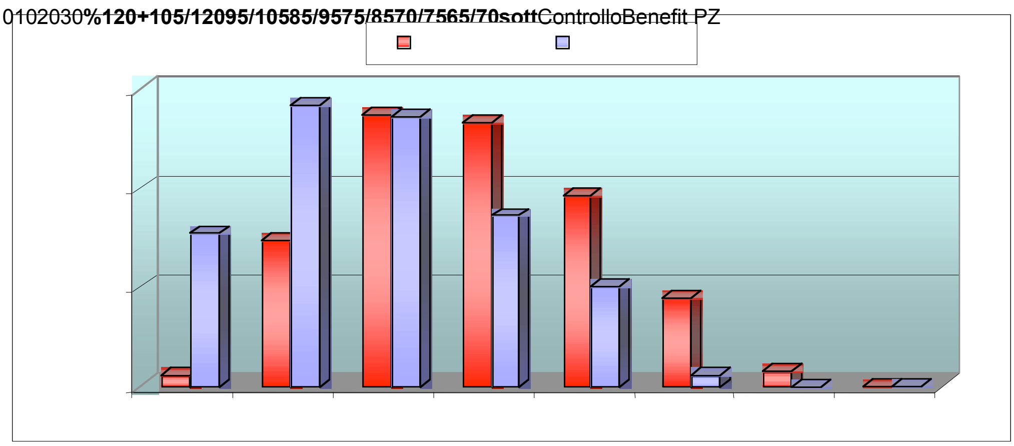

Figure 10- Fruit distribution in marketable classes as affecetd by Benefit PZ application

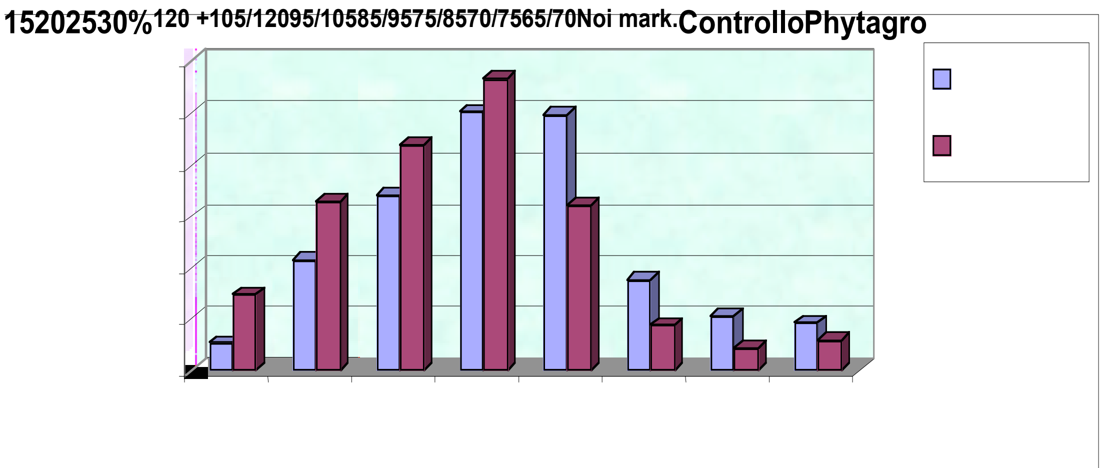

Figure 11- Fruit distribution in marketable classes as affected by Phytagro application