Evaluation of Some Agronomical Characters and Resistance to *Botrytis* of the New Kiwifruit cv. 'Tsechelidis' (*A. deliciosa*) in Comparison to the cv. 'Hayward'

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Abstract

Fruits of the cultivar (cv.) 'Tsechelidis' ripened about one week earlier and at harvesting had significantly higher total soluble solids and acidity, but lower firmness. However, after 4 months at cold storage, there were no significant differences concerning firmness and total soluble sugars for the two cultivars. The new cultivar 'Tsechelidis' had higher yield and fruit weight, fruit uniformity and lower percentage of 'double', 'triple' and 'flat' fruits than 'Hayward'. Therefore, the cost for cultivating this cv. is lower since the labour expenses for thinning and harvest are lower than 'Hayward'. Vines of the cv. 'Tsechelidis' were found to be more resistant to low temperatures that occurred during harvest. Furthermore, artificial inoculations of fruits with conidia of the fungus *Botrytis cinerea* showed that the cultivar 'Tsechelidis' was significant less susceptible than 'Hayward'.

INTRODUCTION

The majority of the commercial kiwifruit plantings worldwide are of the cv. 'Hayward' selected in New Zealand about 70 years ago (Ferguson and Lay Yee, 1983; Ferguson, 1984). Since late 1975, extensive research has been conducted exploring genetic resources in China (*Actinidia* germplasm) (Chat et al., 2004). 70% of the kiwi world production is coming from China, Italy, Chile and N. Zealand (FAO, 2004).

In Greece, the dominant cv. since 1973 is 'Hayward' with a total annual fruit production of 40.000 t and acreage of 4.400 ha (FAO, 2004). However, selection among 15.000 seedlings originated from open pollinated 'Hayward' plants in northern Greece during 1989 by the farmer Christos Tsechelidis, resulted in the new cv. 'Tsechelidis'. Following a molecular genetic analysis of the DNA, it was concluded that the two genotypes ('Hayward', 'Tsechelidis') were different (Ilanidis et al., 2006).

The objective of this study was to compare the new cv. 'Tsechelidis' in comparison to 'Hayward' regarding certain agronomical characteristics as well as fruit quality and resistance to postharvest fungal infections by *Botrytis cinerea*.

MATERIALS AND METHODS

The research was conducted in a kiwifruit orchard (0.5 ha) located in Naoussa, Greece. The vines were planted at a spacing of 4 x 3.5 m and trained in a T-bar trellis system. Irrigation was applied by micro sprinklers and its frequency was determined by using tensiometers. Annual shoots were pruned at 20 buds from the base and flower buds in spring were thinned at prebloom stage. Fertilization was performed according to soil and leaf analyses data.

During December of 2006, five soil samples were collected from a depth of 0-60 cm and analyzed (Jackson, 1960). The soil was characterized as clay loam (clay 26.8, silt 33.1, sand 40.1%) with medium CEC (31.49 meq/100 g), slightly alkaline (pH 7.38), with low electrical conductivity (0.514 mS/cm) and low organic matter (1.11%) and $CaCO_3$ (3.7%) content.

During the harvest of 2006, the following measurements were performed: yield/vine, number of fruits per vine, fruit weight, fruit dimensions, percentage of single,

double, triple and flat fruits, bud fertility and resistance to autumn frost. Furthermore, the following measurements and determinations were performed in ten fruits per replication at harvest time: fruit firmness with an Effegi penetrometer, total soluble solids with an Atago PR-1 electronic refractometer, and acidity as reported by Koukourikou-Petridou et al. (2007).

Single spore isolate of *Botrytis cinerea* was used in this study. The isolates were cultivated in Petri dishes containing potato dextrose agar and incubated at 23°C for 5 days in the dark. Spores of the pathogens were harvested by pouring 3 ml of sterile distilled water in each Petri dish and adjusted to a concentration of 10.000 conidia per ml by using a hemocytometer. Fruits were wounded (3 mm) by using a flamed needle inoculated by adding 40 μl (containing conidia of *B. cinerea* at a concentration of 10.000 per ml) on wound and incubated at cold storage (2-4°C) for 10 days. Results were collected by recording the diameter of rotting.

The experimental design was a randomized block with 5 replications of 2 treatments (cultivars) and 5 trees per plot. Differences between means were evaluated by using one-way ANOVA (Duncan's multiple range test at $P \leq 0.05$).

RESULTS AND DISCUSSION

Phenological observations showed that the cv. 'Tsechelidis' in comparison to the cv. 'Hayward' is slightly earlier in vegetative bud burst (22-25 vs. 27-30 of March), in the onset of flowering (8-10 vs. 13-15 of May) and in the onset of maturity for harvest (20-23 vs. 28-31 of October). Total yield, number of marketable fruits per tree, mean fruit weight, fruit length as well as the ratio fruit length/width were significantly greater in the cv. 'Tsechelidis' than 'Hayward' at harvest (Tables 1 and 2, Fig. 1). The percentage of 'single' fruits was significantly higher for the cv. 'Tsechelidis', whereas the percentage of 'double', 'triple' and 'flat' fruits was lower compared to the cv. 'Hayward' (Table 3). Therefore, the labour cost for thinning the cv. 'Tsechelidis' is lower than that of the cv. 'Hayward'. The higher fruit yield/vine of cv. 'Tsechelidis' (39.6%), a year with severe flower bud damages due to frost, should be attributed to its superior genetic potential. Molecular genetic analysis revealed that the two genotypes were different, since they had polymorphism at least in eight alleles (Ilanidis et al., 2006). The yield superiority of cv. 'Tsechelidis' is based mainly on its large size of fruit. Another way to increase the final fruit size of the cv. 'Hayward' is by the application of biostimulants, as the forchlorfenuron and thidiazuron (Costa and Montefiori, 2002; Famiani et al., 2002). However, the attained final fruit size is even smaller than of the cv. 'Tsechelidis'. The large fruit size, uniformity of shape and the absence of 'flat' fruits give to the cv. 'Tsechelidis' substantial advantages in fruit appearance.

Statistically significant differences were recorded between the 2 cvs. as follows: fruit total soluble solids (TSS) and acidity of the cv. 'Tsechelidis' were higher than 'Hayward', whereas fruit firmness was lower at harvest (Table 4). However, after 4 months at cold storage, there were no significant differences concerning firmness and total soluble sugars for the two cultivars (Table 5). Fruits of the cv. 'Tsechelidis' ripened about one week earlier than fruits of the cv. 'Hayward'. This was verified by the course of TSS concentration and the significantly lower firmness (10.4 vs. 12.23 kg). Crisosto et al. (1984) reported that a combination of the initial TSS at harvest and flesh firmness seemed to be a good maturity index for kiwifruit. It has been referred that kiwifruit harvested with <6,2% TSS developed flesh breakdown (Crisosto and Crisosto, 2001).

The fertile buds from the base of the shoot were the 1st or the 2nd for the cv. 'Tsechelidis', whereas for the cv. 'Hayward' the 5th or the 6th (Table 6). Vines of the cv. 'Tsechelidis' were found to be more resistant to low temperatures that occurred during harvest. Especially, vines of the cv. 'Tsechelidis' after an autumn frost (-3°C on November 5 at harvest) had a higher percentage of bud sprout at spring of the next year than the cv. 'Hayward' (Table 6).

Artificial inoculations of fruits showed that the cultivar 'Tsechelidis' was significantly less susceptible than the cultivar 'Hayward' (Table 6).

CONCLUSIONS

Total yield, number of marketable fruits per tree, mean fruit weight, fruit length as well as the ratio fruit length/width were significantly greater in cv. 'Tsechelidis' than 'Hayward' at harvest. The percentage of 'single' fruits was significantly higher for the cv. 'Tsechelidis', whereas the percentages of 'double', 'triple' and 'flat' fruits were lower compared to the cv. 'Hayward'. The higher fruit yield/vine of cv. 'Tsechelidis', a year with severe flower bud damages due to frost, should be attributed to its superior genetic potential. The yield superiority of cv. 'Tsechelidis' is based mainly on its large size of fruit. Statistically significant differences were recorded between the 2 cvs. as follows: fruit total soluble solids and acidity of the cv. 'Tsechelidis' were higher than 'Hayward', whereas fruit firmness was lower at harvest. However, after 4 months at cold storage, there were no significant differences concerning firmness and total soluble sugars for the two cultivars. Vines of the cv. 'Tsechelidis' were found to be more resistant to low temperatures that occurred during harvest. Artificial inoculations of fruits with conidia of the fungus *Botrytis cinerea* showed that the cultivar 'Tsechelidis' was significantly less susceptible than 'Hayward'. In conclusion, this is the first step for evaluating the new cv. 'Tsechelidis', but from the results presented above it appears that this new cv. is very promising.

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Tables

Table 1. Yield data of the cvs. 'Tsechelidis' and 'Hayward' at harvest of 2006.

Cultivar	Yield (kg/vine)			Number of fruits/vine		
	Marketable	Non marketable	Total	Marketable	Non marketable	Total
'Tsechelidis'	41.60 a[x]	0.16 b	41.76 a	249 a	1 b	250 b
'Hayward'	25.10 b	4.82 a	29.92 b	222 b	57 a	279 a

[x]Means followed by the same letter in the same column are not significantly different (Duncan's multiple range test, P≤0.05).

Table 2. Kiwifruit dimensions and mean weight of the cvs. 'Tsechelidis' and 'Hayward' at harvest of 2006.

Cultivar	Fruit dimensions					Mean fruit weight (g)	
	Length (cm)	Width (cm)	Height (cm)	Length/ Width	Width/ Height	Marketable	Non marketable
'Tsechelidis'	6.84 a[x]	4.58 a	3.80 a	1.50 a	1.21 a	167.0 a	237.0 a
'Hayward'	6.08 b	4.42 a	3.60 a	1.38 b	1.22 a	114.5 b	88.8 b

[x]Means followed by the same letter in the same column are not significantly different (Duncan's multiple range test, P≤0.05).

Table 3. Percentage of 'single', 'double', 'triple' and 'flat' fruits per vine of the cvs. 'Tsechelidis' and 'Hayward' at harvest of 2006.

Cultivar	'Single' fruits (%)	'Double' fruits (%)	'Triple' fruits (%)	'Flat' fruits (%)
'Tsechelidis'	83.3 a[x]	9 b	6 b	1.7 b
'Hayward'	60.6 b	11 a	17.5 a	10.9 a

[x]Means followed by the same letter in the same column are not significantly different (Duncan's multiple range test, P≤0.05).

Table 4. Fruit firmness, total soluble solids and acidity of fruits of the cvs. 'Tsechelidis' and 'Hayward' at harvest of 2006.

Cultivar	Fruit firmness (kg)	Total soluble solids (%)	Acidity (%)
'Tsechelidis'	10.4 b[x]	6.6 a	2.88 a
'Hayward'	12.23 a	6.18 b	2.24 b

[x]Means followed by the same letter in the same column are not significantly different (Duncan's multiple range test, P≤0.05).

Table 5. Fruit firmness and total soluble solids of fruits of the cvs. 'Tsechelidis' and 'Hayward' after 4 months at cold storage.

Cultivar	Fruit firmness (kg)	Total soluble solids (%)
'Tsechelidis'	6.6 a[x]	14.20 a
'Hayward'	6.7 a	14.05 a

[x]Means followed by the same letter in the same column are not significantly different (Duncan's multiple range test, P≤0.05).

Table 6. Bud fertility from the base of the shoot, resistance to autumn frost, width and height of infected area of kiwifruit after artificial infection with *Botrytis cinerea* of fruits the cvs. 'Tsechelidis' and 'Hayward'.

Cultivar	Fertile bud from the base of the shoot	Bud sprout at spring after autumn frost[y] (%)	Width (mm)	Height (mm)
'Tsechelidis'	1st-2nd	79 a[x]	17.16 b	21.19 b
'Hayward'	5-6th	51 b	23.12 a	30.91 a

[y]-3°C at November 5 at harvest.

[x] Means followed by the same letter in the same column are not significantly different (Duncan's multiple range test, P≤0.05).

Figures

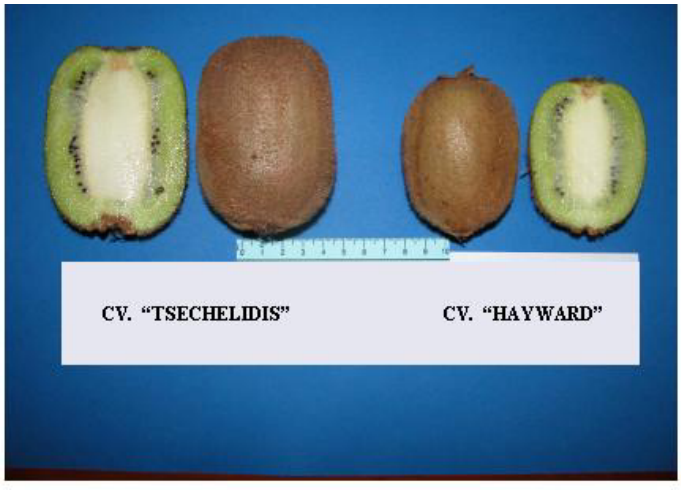

Fig. 1. Representative kiwifruits of the cvs. 'Tsechelidis' and 'Hayward'.