

Adaptation of twenty peach and nectarine varieties in Kos and their susceptibility to *Plum pox virus* and *Phytophthora citrophthora*

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ABSTRACT: Twenty peach and nectarine (*Prunus persica* [L.] Batsch) varieties (Morettini No. 1, Coronet, Dixired, Jerseyland, Gialla Precoce Morettini, Cardinal, Golden Jubilee, Red Haven, Belle di Georgia, Early Elberta, Elberta, J.H. Hale, Rio Oso Gem, Desert Gold, Spring Time, June Gold, Red Cup, Flavor Top, Fantasia, Flame Kist) grafted on wild peach seedlings were evaluated for 10 years in the Greek island Kos. The results showed that some peach and nectarine varieties with high chilling requirements such as Red Haven (950 hrs) gave satisfactory yield in the soil and climatic conditions of Kos, where the mean duration of temperatures below 7°C was found to be about 150 hr. Bloom and maturity dates were different in the same varieties in Kos compared to their standard bloom and maturity dates in Naoussa. Regarding a response to *Plum pox virus* the varieties Jerseyland, Gialla Precoce Morettini, Desert Gold and Spring Time were the most resistant whereas Dixired, Red Haven, Belle Di Georgia and Red Cup were the most susceptible to the disease. No significant difference was found in the susceptibility of peach and nectarine varieties to *Phytophthora citrophthora*.

Keywords: peaches; nectarines; bloom; chilling requirements; fruit quality; productivity; *Plum pox virus* resistance

Peach is one of the most important fruit crops cultivated in Greece. Peach trees are cultivated mainly in northern Greece, where conditions are excellent. The main limiting factor for an extensive cultivation of peaches and nectarines in southern areas is temperature (BOWEN 1971). Insufficient chilling accumulation can cause a bud fall, a delay of bloom and a poor shoot bud growth (WERNER et al. 1988). Many researchers relate a breaking of dormancy with accumulation of chilling units (RICHARDSON et al. 1974) and believe that 6°C is the best temperature for breaking dormancy. Others found that 7.2°C were more active than 3 or 2°C (SCALABRELLI, COUVILLON 1986). The majority of peach and nectarine varieties require 800–1,000 hours (WANG, HU 1992) although there are varieties with low chilling requirements (BOWER 1971; SHERMAN 1988). The aim of this study was to evaluate the adaptation of twenty peach – nectarine varieties to the soil and climatic conditions that are prevalent in the island

Kos and their susceptibility to *Phytophthora citrophthora* *in vitro*.

Twenty peach – nectarine varieties (Morettini No. 1, Coronet, Dixired, Jerseyland, Gialla Precoce Morettini, Cardinal, Golden Jubilee, Red Haven, Belle Di Georgia, Early Elberta, Elberta, J.H. Hale, Rio Oso Gem, Desert Gold, Spring Time, June Gold, Red Cup, Flavour Top, Fantasia, Flame Kist) were grafted on wild peach seedlings and established in the experimental field of National Agricultural Research Foundation (NAGREF) of Kos in 1985. The planting distances were 4 × 4 m. This orchard was evaluated for ten years (1990–2000) and compared with the collection of the same varieties established in the experimental field of NAGREF in Naoussa (northern Greece). All trees were trained to a vase shape with three to five main branches and three sub-branches per tree. During experimentation, all cultural practices were carried out as in a standard commercial practice (pruning, spraying, thinning,

Table 1. Results of soil analyses in the experimental orchards in Naoussa and Kos

Depth (cm)	Clay (%)	Loam (%)	Sand (%)	Characterization of soil	Electrical conductivity (MMHOS/cm)	PH in pulp	Free CaCO ₃ (%)
Kos							
0–30	31.0	32.0	37.0	CL	< 3	7.8	26
30–60	36.0	30.0	34.0	CL	< 3	7.8	31
60–90	27.0	27.0	46.0	SCL	< 3	7.8	29
Naoussa							
0–30	34.2	29.8	36.0	CL	< 3	7.2	4.7
30–60	44.4	25.2	30.4	L	< 3	7.5	7.8
60–90	39.6	30.0	30.4	CL	< 3	7.8	7.2

Values are the means of four samples

SCL = Sand – Clay – Loam, SL = Sand – Loam, CL = Clay – Loam, L = Loam

Table 2. Mean temperatures (°C) in the experimental fields in Kos and Naoussa during 1990–2000

Months	Kos	Naoussa
January	8.8	0.3
February	8.2	1.3
March	9.7	4.2
April	12.7	7.9
May	15.7	11.9
June	19.3	15.4
July	21.7	17.5
August	21.6	17
September	19.8	14.5
October	16.4	10.1
November	12.7	5.4
December	10.2	1.4

irrigation, etc.). Observations were made on the behaviour of different varieties including bloom date, fruit maturity, yield and fruit weight and susceptibility to *Plum pox virus*. In addition, the susceptibility of the varieties to *Phytophthora citrophthora* was tested *in vitro* by using the excised twig assay and excised shoot method described analytically by THOMIDIS (2000) and THOMIDIS et al. (2001).

In both orchards, the experimental design was completely randomized with three replications of three trees each. One hundred fruits were collected from each tree and used to measure fruit weight.

The altitude of the orchard in Kos was 5 m above sea level and the distance from the sea was 1,500 m. The altitude of the orchard in Naoussa was 132 m above sea level and the distance from the sea was about 100 km.

The results of soil analyses are presented in Table 1. Besides, the temperatures throughout this pe-

riod of observations were recorded by establishment of meteorological stations (Table 2). In Naoussa, temperatures fall below 7°C for more than 1,000 hrs, which are adequate to cover the requirements of all varieties. The water used for irrigation was of good quality containing a low level of calcium, magnesium and sodium in both orchards.

In Kos some varieties bloomed and their fruits ripened earlier than, others at the same time as and others later than in Naoussa (Table 3). The results are in agreement with those found by TSIPOURIDIS et al. (2002). This fact needs to be taken into account in the case of self-sterile varieties. For example, the self-sterile variety J.H. Hale is a cross pollinated by cvs. Cardinal and Red Haven, which bloom at the same time as J.H. Hale in Naoussa. These varieties are not good mutual pollinators in Kos because their blooming period is different. Thus, a different pollinator should be used that blooms at the same time as J.H. Hale. Early blooming possibly occurred due to adequate chilling to cover all requirements of varieties and favourable high temperatures advanced floral-shoot bud burst. Generally, the ripening period of fruits showed the same tendency as the blooming period (Table 3).

In Kos, the highest yield per tree was found in the varieties Jerseyland, Morettini No. 1, Flavour Top and Golden Jubilee and the lowest in Gialla Precoce Morettini, Spring Time, Cardinal and Coronet. All the varieties showed much lower productivity there than the normal productivity in Naoussa (northern Greece) (Table 4). The varieties J.H. Hale, Red Haven and Fantasia produced the highest fruit weight while the varieties Desert Gold, Spring Time and Red Cup produced the lowest fruit weight in Kos (Table 4). The fruit weight of the tested varieties was lower than that in Naoussa. Only Morettini No. 1, Early

Table 3. Bloom and maturity periods of peach and nectarine varieties

Varieties	Bloom		Maturity	
	Kos	Naoussa	Kos	Naoussa
Belle Di Georgia	29. 3.	27. 3.	12. 8.	18. 8.
Cardinal	6. 4.	22. 3.	16. 7.	29. 6.
Coronet	28. 3.	25. 3.	13. 7.	12. 7.
Desert Gold	30. 1.	7. 3.	4. 6.	27. 6.
Dixired	10. 4.	23. 3.	5. 7.	2. 7.
Early Elberta	3. 4.	22. 3.	13. 8.	18. 8.
Elberta	31. 3.	27. 3.	7. 8.	28. 7.
Fantasia	29. 3.	18. 3.	1. 8.	11. 8.
Flame Kist	23. 3.	20. 3.	22. 8.	30. 8.
Flavour Top	22. 3.	19. 3.	26. 7.	3. 8.
G. Prec. Morettini	20. 3.	25. 3.	26. 6.	30. 6.
Golden Jubilee	31. 3.	26. 3.	19. 7.	21. 7.
J.H. Hale	31. 3.	22. 3.	14. 8.	22. 8.
Jerseyland	2. 4.	28. 3.	10. 7.	9. 7.
June Gold	14. 3.	13. 3.	19. 6.	25. 6.
Morettini No. 1	31. 3.	2. 4.	26. 6.	5. 7.
Red Cup	24. 3.	24. 3.	24. 6.	4. 7.
Red Haven	4. 4.	28. 3.	17. 7.	10. 7.
Rio Oso Gem	1. 4.	27. 3.	27. 8.	25. 8.
Spring Time	18. 3.	16. 3.	5. 6.	12. 6.

Mean of ten years

Table 4. Productivity and mean weight of fruits (100 fruits per tree) of peach and nectarine varieties

Varieties	Kos		Naoussa	
	Mean weight of fruits	Productivity (kg/tree)	Mean weight of fruits	Productivity (kg/tree)
Belle Di Georgia	137 ^a g ^b	18.9 fg	168 e	40.8 jk
Cardinal	154 f	13.8 h	160 f	36.4 kl
Coronet	130 h	14.3 h	180 cd	95.0 c
Desert Gold	91 l	17.3 g	126 j	43.0 hj
Dixired	122 j	17.3 g	143 h	48.2 gh
Early Elberta	168 cd	20.8 de	155 fg	32.2 l
Elberta	154 f	22.6 bc	203 b	103.8 b
Fantasia	173 bc	19.7 ef	183 c	42.0 j
Flame Kist	165 de	21.6 cd	180 cd	64.0 ef
Flavour Top	125 j	23.1 bc	158 fg	34.5 kl
G. Prec. Morettini	160 e	11.7 j	141 h	86.6 d
Golden Jubilee	171 bc	30.7 a	147 gh	114.5 a
J.H. Hale	180 a	17.1 g	231 a	51.5 g
Jerseyland	162 e	24.1 b	175 de	111.1 a
June Gold	134 gh	20.7 de	176 de	50.0 g
Morettini No. 1	163 de	23.4 bc	152 fg	58.4 f
Red Cup	105 k	16.9 g	158 f	57.6 f
Red Haven	176 ab	20.4 de	179 cd	86.8 d
Rio Oso Gem	154 f	16.7 g	180 cd	67.2 e
Spring Time	94 l	13.7 h	95 k	45.3 gh

^aValues are the means of 10 years

^bAnalysis of variance (ANOVA) was used to analyze the data and treatment means were separated using Duncan's Multiple Range Test (< 0.05)

Table 5. Susceptibility of peach and nectarine varieties to *Plum pox virus*

Varieties (Naoussa)	Index E	Varieties (Rhodes)	Index E
Belle Di Georgia	2.28 ^a ab	Belle Di Georgia	2.30 a
Cardinal	1.74 ab	Cardinal	1.48 ab
Coronet	1.65 ab	Coronet	1.71 a
Desert Gold	0.79 b	Desert Gold	0.68 b
Dixired	2.16 a	Dixired	1.99 a
Early Elberta	1.65 ab	Early Elberta	1.71 a
Elberta	1.47 ab	Elberta	1.50 ab
Fantasia	1.52 ab	Fantasia	1.44 ab
Flame Kist	1.32 ab	Flame Kist	1.28 b
Flavour Top	1.97 a	Flavour Top	2.12 a
G. Prec. Morettini	0.67 b	G. Prec. Morettini	1.02 b
Golden Jubilee	1.28 ab	Golden Jubilee	1.30 ab
J.H. Hale	1.33 ab	J.H.Hale	1.44 ab
Jerseyland	0.70 b	Jerseyland	1.12 b
June Gold	1.21 ab	June Gold	1.42 ab
Morettini No. 1	1.72 ab	Morettini No 1	1.66 ab
Red Cup	2.02 a	Red Cup	1.98 a
Red Haven	2.14 a	Red Haven	2.08 a
Rio Oso Gem	1.40 ab	Rio Oso Gem	1.32 ab
Spring Time	0.84 b	Spring Time	0.74 b

^aValues are the means of 10 years

^bAnalysis of variance (ANOVA) was used to analyze the data and treatment means were separated using Duncan's Multiple Range Test (< 0.05)

Table 6. Susceptibility of peach and nectarine varieties to *P. citrophthora*

Varieties	Excised shoot	Excised twig
Belle Di Georgia	3.22 ^a ab	2.45 a
Cardinal	2.99 a	2.21 a
Coronet	3.06 a	2.37 a
Desert Gold	3.19 a	2.19 a
Dixired	2.97 a	2.20 a
Early Elberta	3.30 a	2.40 a
Elberta	3.11 a	2.37 a
Fantasia	3.28 a	2.32 a
Flame Kist	3.15 a	2.26 a
Flavour Top	3.22 a	2.39 a
G. Prec. Morettini	3.20 a	2.41 a
Golden Jubilee	3.17 a	2.35 a
J.H. Hale	3.00 a	2.27 a
Jerseyland	3.14 a	2.41 a
June Gold	3.27 a	2.33 a
Morettini No. 1	3.10 a	2.43 a
Red Cup	3.09 a	2.28 a
Red Haven	3.13 a	2.34 a
Rio Oso Gem	3.18 a	2.43 a
Spring Time	3.20 a	2.30 a

^aValues are the means of three experiments

^bAnalysis of variance (ANOVA) was used to analyze the data and treatment means were separated using Duncan's Multiple Range Test (< 0.05)

Elberta, Golden Jubilee and Gialla Precoce Morettini produced fruits with lower weight. Probably, it is due to the much higher productivity of trees in Naoussa.

Many peach and nectarine varieties with quite high chilling requirements gave a relatively satisfactory yield in Kos, where the mean temperatures below 7°C for one decade were much lower than those normally required by these varieties (about 150 hr). It was found that chilling requirements of peach and nectarine varieties differed from place to place (FRECON 1988). PHYLLIS et al. (1981) reported that continuous exposure of the nectarine variety Sun Gold to 10°C was as effective as in the case of 7°C. Although the per-hectare yield is relatively low in Kos, farmers may achieve high prices and the per-hectare profit is relatively high because the fruits (if the consumption of fruits occurs at the place of production) can be harvested at full maturity being more tasty and achieving a larger size of the fruits than those in northern Greece.

The peaches produced there take advantage of lower transportation costs, which is also safer, and it is not dependent on the schedules of ferryboats.

Plum pox virus (PPV), the causal agent of sharka disease of stone fruit trees (DUNEZ, SUTIC 1988), is considered to be one of the most destructive fruit-tree viruses. The use of PPV-resistant varieties was identified in a number of *Prunus* species (KEGLER et al. 1998; MOUSTAFA et al. 2001; POLÁK et al. 1997; RAVELONANDRO, DUNEZ 1995). The most resistant varieties in both Naoussa and Rhodes were Jerseyland, Gialla Precoce Morettini, Desert Gold and Spring Time and the most susceptible were Dixired, Red Haven, Belle Di Georgia and Red Cup (Table 5).

The results showed no differences in susceptibility of the tested varieties to *Phytophthora citrophthora* (Table 6). Similarly, THOMIDIS (2000, 2001) found that the susceptibility of peach rootstocks KID I, PR204, GF677 and GF305 to *P. citrophthora* did not differ.

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Adaptabilita dvaceti odrůd nektarinek a broskvoní k podmínkám ostrova Kos a jejich citlivost na virovou šarku a vůči *Phytophthora citrophthora*

ABSTRAKT: Celkem 20 odrůd broskvoní a nektarinek (*Prunus persica* [L.] Batsch) (Morettini č. 1, Coronet, Dixired, Jerseyland, Gialla Precoce Morettini, Cardinal, Golden Jubilee, Red Haven, Belle di Georgia, Early Elberta, Elberta, J.H. Hale, Rio Oso Gem, Desert Gold, Spring Time, June Gold, Red Cup, Flavor Top, Fantasia, Flame Kist) bylo naštěpováno na semenáče planých broskvoní a 10 let hodnoceno na řeckém ostrově Kos. Výsledky práce ukázaly, že některé odrůdy broskvoní a nektarinek s vysokými požadavky na období chladu, jako jsou Red Haven (vyžadující normálně 950 hodin chladu), uspokojivě plodí v půdních a klimatických podmínkách ostrova Kos, kde průměrná doba trvání teplot pod 7°C dosahuje hodnoty jen kolem 150 hodin. Začátky doby kvetení a zralosti plodů u stejných odrůd však byly na ostrově Kos odlišné od těch, jaké jsou v oblasti Naoussa. Jako odolné k virové šarce byly zjištěny odrůdy Jerseyland, Gialla Precoce Morettini, Desert Gold a Spring Time, zatímco jako nejcitlivější se k této chorobě projevíly odrůdy Dixired, Red Haven, Belle Di Georgia a Red Cup. Naproti tomu nebyly zjištěny žádné významné rozdíly v citlivosti hodnocených odrůd broskvoní a nektarinek vůči *Phytophthora citrophthora*.

Klíčová slova: broskvoně; nektarinky; kvetení; požadavky na chlad; kvalita plodů; výnosy; odolnost vůči virové šarce

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