

ANNALI

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A FACTORIAL EXPERIMENT ON *CITRUS* STOCK/SCION COMBINATIONS IN SARDINIA

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SUMMARY

Five *Citrus* varieties ("Washington navel", "Tarocco", "Biondo comune", "Valencia" sweet oranges, and "Avana" mandarin) on different rootstocks (sour orange, "Troyer" citrange, citremon 1449, *Poncirus trifoliata* "Rubidoux", "Orlando" tangelo), and at two planting distances (4x4 m, 5x5 m) were evaluated for 3 years in a factorial experiment, with a completely randomized design. Observations were made on growth, productivity and fruit quality. Tree growth, productivity and fruit quality were affected both by variety and by rootstock and planting distance. "Valencia" and "Biondo comune" showed the best growth and yield, and "Avana" mandarin the poorest. Several differences in fruit quality were observed in the different varieties, mostly concerning fruit weight, rind thickness, juice, TSS and TA. The rootstock also affected growth, yield and fruit characteristics. The growth was decreased by "Rubidoux" trifoliolate orange, while the yield was slightly increased by "Troyer", "Rubidoux" and "Orlando". "Rubidoux" and citremon improved several fruit characteristics, such as rind thickness, juice, and TSS content. As the trees were still young, planting distance did not affect growth, but some small differences were found in fruit quality. The yield/tree and the efficiency were increased by 5x5 m treatment, while the yield/ha was, on the contrary, higher in 4x4 m treatment. Finally, some interactions were found between variety and rootstock.

Keywords: Citrus, Rootstock, Yield, Fruit quality.

RIASSUNTO

Esperienze su combinazioni d'innesto di alcune cultivar di agrumi in Sardegna

Il comportamento di cinque cultivar di agrumi ("Washington navel", "Tarocco", "Biondo comune", "Valencia", e mandarino "Avana") è stato valutato per tre anni consecutivi in combinazione con cinque portinnesti (arancio amaro, citrange "Troyer", citremon 1449, arancio trifogliato "Rubidoux" e tangelo "Orlando") e a diverse distanze di piantagione (m 4x4 e m 5x5), adottando uno schema fattoriale e parcelle completamente randomizzate.

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Le osservazioni hanno messo in evidenza che l'accrescimento, la produzione e le caratteristiche dei frutti sono stati influenzati dalla varietà, dal portinnesto e dalla distanza di impianto. Le cultivar "Valencia" e "Biondo comune" si sono dimostrate le più vigorose e produttive nei confronti, soprattutto del mandarino "Avana".

Nelle diverse cultivar sono state riscontrate, ovviamente, differenze significative relative al peso dei frutti, spessore della buccia, contenuto in succo, solidi totali solubili e acidità. Anche i portinnesti hanno avuto influenza sensibile sia sulla vigoria che sulla produttività. In particolare l'accrescimento è stato ridotto dall'arancio trifogliato, mentre la produzione è stata leggermente favorita dal citrange, dall'arancio trifogliato e dal tangelo. L'arancio trifogliato e il citremon hanno migliorato alcune caratteristiche dei frutti, in particolare lo spessore della buccia, il contenuto in succo e i solidi totali solubili.

Le distanze di impianto, trattandosi di piante ancora giovani, non ne hanno influenzato la vigoria, mentre alcune piccole differenze si sono notate sulla qualità dei frutti. La produzione per pianta e l'efficienza produttiva sono state incrementate alle distanze di m 5x5, mentre la produzione ad ettaro, al contrario, è risultata più elevata alle distanze di m 4x4. Sono state, infine, riscontrate alcune interazioni significative tra cultivar e portinnesto.

Parole chiave: Agrumi, Portinnesto, Produzione, Qualità dei frutti.

INTRODUCTION

Previous research has been carried out in Sardinia with the purpose of finding new rootstocks for orange and grapefruit, and the related results have been already referred in a series of reports (1,2,3,4,5,6,7). The present study is a further contribution to this topic.

MATERIAL AND METHODS

Five *Citrus* varieties ("Washington navel", "Tarocco", "Biondo comune", "Valencia" sweet oranges, and "Avana" mandarin) on different rootstocks (sour orange, "Troyer" citrange, citremon 1449, *Poncirus trifoliata* "Rubidoux", "Orlando" tangelo), and at two planting distances (4x4 m, 5x5 m) were evaluated for three years in a factorial experiment, with a completely randomized design. Four 1-tree replications for each stock/scion combination and planting distance were arranged in an experimental field located in south-western Sardinia. Observations were made on tree growth, yield, and fruit quality from 1987 to 1989. The growth was evaluated through measurements of the canopy height and width. The canopy volume was determined by Turrel's formula (8).

The yield was recorded at harvest time, when fruit samples were collected for quality determinations. All data were subjected to statistical analysis.

RESULTS

Tree growth, productivity and fruit quality were affected both by variety and by rootstock and planting distance. “Valencia” and “Biondo Comune” oranges showed the best growth and yield, and “Avana” mandarin the poorest (table 1). Several differences in fruit characteristics were obviously observed in the different varieties, mostly concerning fruit weight, rind thickness, juice, TSS and TA (table 2). But the rootstock also affected growth, yield and fruit quality. In general the growth and the yield were increased by “Orlando” tangelo and “Troyer” citrange, while the efficiency was improved by “Rubidoux” trifoliate orange and “Orlando” tangelo.

Table 1 - Growth and yield of five *Citrus* varieties on different rootstocks and planting distances (3-year average values).

	Tree height cm	Canopy volume m ³	Yield		Effic. Kg/m ³	Fruit weight g
			Kg/tree	t/ha		
Variety (A)						
Wash. navel	308b	15.1a	37.5b	19.2b	2.7a	261c
Tarocco	315b	13.7a	48.8c	25.0c	3.8c	251c
Biondo com.	349c	19.6b	54.4d	27.9d	3.0b	216b
Valencia	351c	22.2b	56.9d	29.2d	2.6a	229b
Avana	266a	13.5a	29.4a	15.1a	2.7a	89a
Sign.	**	**	**	**	**	**
Rootstock (B)						
Sour or.	320	16.8ab	43.0a	22.0a	2.6a	203a
Troyer	324	18.5c	47.4b	24.3b	2.8a	214b
Citremom	318	16.0a	43.0a	22.0a	2.8a	205a
Rubidoux	307	15.2a	43.3a	22.2a	3.1b	211b
Orlando	320	17.7bc	50.4c	25.8c	3.5c	212b
Sign.	NS	*	**	*	**	**
Distance (C)						
4x4 m	322	17.0	42.2	26.6	2.6	211
5x5 m	313	16.4	48.7	19.8	3.3	207
Sign.	NS	NS	**	**	**	*
Interact.						
A x B	**	**	**	**	**	**
A x C	*	*	**	**	**	NS

Fruit weight was slightly increased by "Troyer", "Rubidoux" and "Orlando". "Rubidoux" and citremon improved several other fruit characteristics, such as rind thickness, juice and TSS content. Furthermore some interactions were found between variety and rootstock (table 1). In fact in "Washington navel" and "Tarocco" oranges the tree growth was increased by sour orange, while "Orlando" tangelo and "Troyer" citrange induced the best growth in the other varieties (figure 1).

The highest yield was given by "Orlando" tangelo in "Tarocco" and "Washington navel" oranges, by "Troyer" citrange in "Biondo comune" and "Valencia" oranges, and by sour orange in "Avana" mandarin (figure 2). On the other hand, "Orlando" tangelo induced the best efficiency in all the varieties tested, except in "Valencia" orange, where it resulted highest with "Troyer" citrange (figure 3).

Table 2 - Fruit quality of five *Citrus* varieties on different rootstocks and planting distances (3-year average values).

	Rind thick. mm	Seeds per fruit	Juice %	TSS %	TA %	TSS/TA
Variety (A)						
Wash. navel	6.6c	0.2a	48.5c	10.5d	0.74b	14.2bc
Tarocco	5.8b	0.4a	53.2e	10.1b	1.01c	10.0a
Biondo com.	7.2d	9.6b	45.7b	10.4cd	0.73b	14.2bc
Valencia	6.7c	1.6a	50.6d	9.8a	0.75b	13.1b
Avana	2.9a	13.0c	41.3a	10.2bc	0.62a	16.4c
Sign.	**	**	**	**	**	**
Rootstock (B)						
Sour or.	6.2c	5.4b	46.5a	10.3b	0.79b	13.0
Troyer	5.9b	5.4b	47.6b	10.0a	0.72a	13.9
Citremon	5.6a	3.9a	49.1c	10.6c	0.79b	13.4
Rubidoux	5.6a	4.6ab	49.6c	10.3b	0.78b	13.2
Orlando	5.8ab	5.5b	46.6a	9.8a	0.76ab	12.9
Sign.	**	**	**	**	*	NS
Distance (C)						
4x4 m	5.8	4.9	47.8	10.1	0.74	13.6
5x5 m	5.8	5.0	47.9	10.3	0.79	13.0
Sign.	NS	NS	NS	*	**	NS

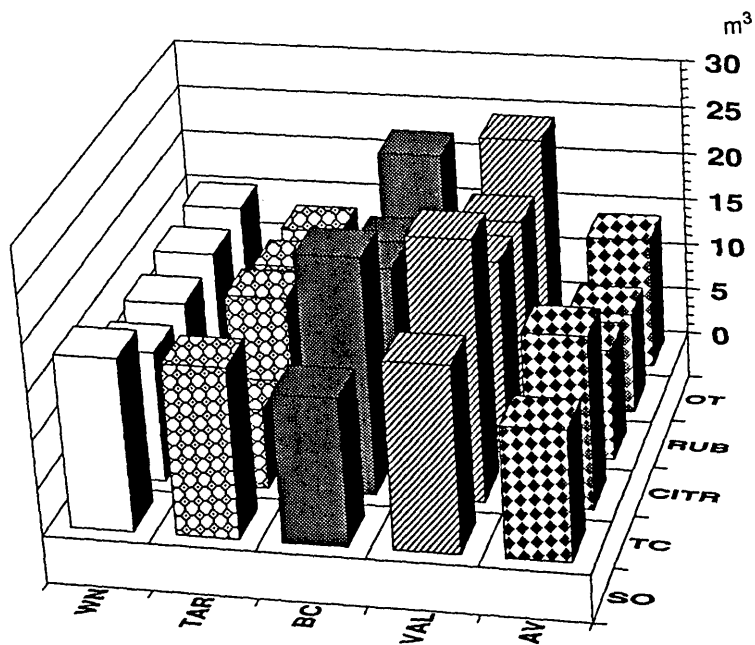


Fig. 1 - Canopy volume in relation to the different stock/scion combinations.

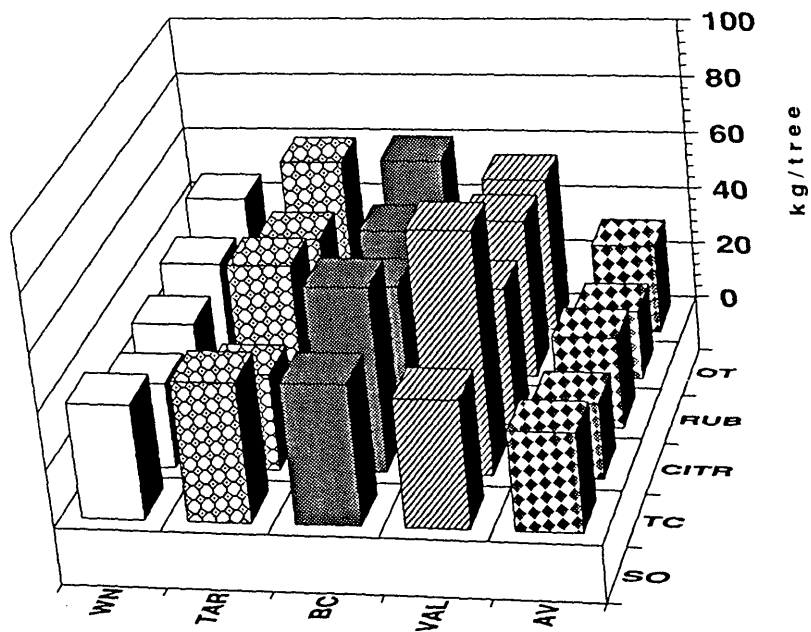


Fig. 2 - Tree yield in relation to the different stock/scion combinations.

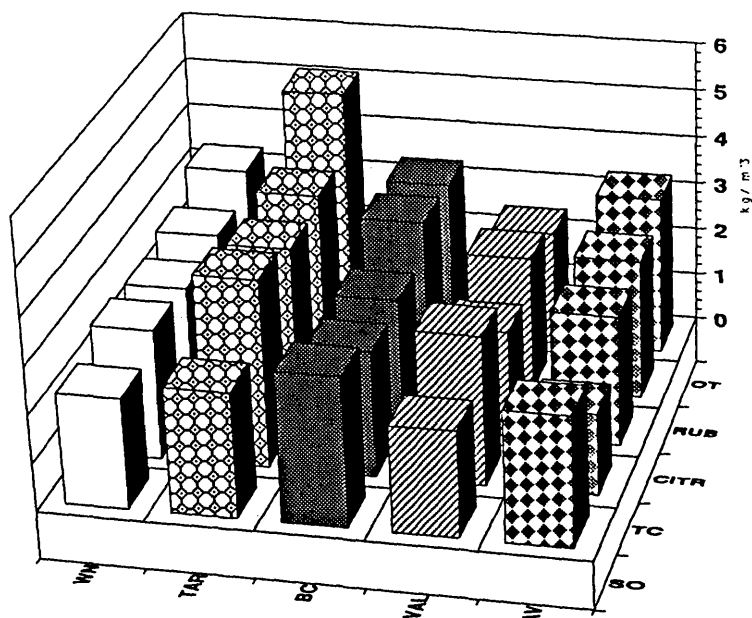


Figure 3 - Yield efficiency in relation to the different stock/scion combinations.

As far as the fruit quality is concerned, fruit weight was improved by “Orlando” tangelo and “Troyer” citrange in “Washington navel” and “Tarocco” oranges, by “Rubidoux” in “Biondo comune” orange, and by “Troyer” citrange in “Valencia” orange and “Avana” mandarin. In all the varieties, as mentioned above, “Rubidoux” trifoliolate orange and citremon improved rind thickness, juice and TSS content, while only small differences were found on total acids. Finally, the planting distance, as the trees were still young, did not affect growth, but the yield/tree and the efficiency were increased by 5x5 m treatment, and the yield/ha was, on the contrary, higher in 4x4 m treatment (table 1). A little increase of the fruit weight was found in 4x4 m treatment (table 1), and a small increase of TSS and TA content was induced by 5x5 m treatment (table 2). No significant interactions were found between planting distance, variety and rootstock.

CONCLUSIONS

These results confirmed that some rootstocks, like “Troyer” citrange, “Rubidoux” trifoliolate orange and citremon could be suitable substitutes for sour orange, should there be a *Tristeza* infection. “Orlando” tangelo also appeared promising, since in most varieties it improved the growth and the yield; but, on the other hand, it

induced negative effects on fruit quality. Several interactions between variety and rootstock were found in this research, so that a given rootstock could be suitable for one variety, but not for another. Finally, the work in progress will give better information, since at the moment the trees are still young.

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Lavoro pervenuto in redazione il 20-12-1991.

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