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Economic advantages of high-density planting of almond orchards

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SUMMARY - The economic advantages of two planting distances (5x5 m and 5x2.5 m) were compared for three different varieties of almond (Supernova, Tuono and Ferragnes). The trial orchard was located at the "Pantanello" experimental field station at Metaponto in the Basilicata region (southern Italy). One-year-old scions were planted in 1983-84 and after ten years half the plants were removed from the orchard planted at 5x2.25 m to obtain an overall 5x5 m planting distance. Cumulated crop production was higher in the training phase for the 5x2.5 m plants, but when the plants reached full maturity the difference was attenuated and at the end of the tenth year was higher for the 5x5 m plants. No significant difference between cultivars was revealed, hence confirming their reported validity. Comparison of the main costs (planting, training, etc.) to evaluate the economic advantages demonstrated that high-density planting in almond culture is of very limited interest.

Key words: Almond, high density planting, economic convenience.

RESUME - "Avantages économiques d'une plantation à forte densité dans des vergers d'amandier". La convenance économique de deux différentes distances de plantation (5x5 m et 5x2,5 m) a été comparée pour trois variétés (Ferragnes, Supernova et Tuono). L'essai a été conduit dans l'Azienda Sperimentale "Pantanello" à Metaponto, région de Basilicata (Sud de l'Italie). La plantation a été effectuée dans l'hiver 1983-84 et après dix années un arbre sur deux a été éliminé pour mettre la plantation à la même distance de 5x5 m. Nous avons observé que la production cumulée par arbre, à la fin de la dixième année, est plus élevée avec les arbres plantés à 5x5 m. Au contraire la production par hectare est plus élevée dans la phase initiale avec la plantation plus serrée, mais à partir du moment où les arbres ont atteint la pleine production, les différences sont diminuées. Entre les variétés nous n'avons pas constaté de différences, ce qui confirme la validité des trois variétés. La comparaison entre les coûts de production (plantation, conduit, etc.), pour évaluer la convenance économique de l'intensification des plantations, a démontré que pour l'amandier ceci a un intérêt très limité.

Mots-clés : Amandier, distances de plantation, convenance économique.

Introduction

In Italy, high-density planting in fruit growing is of major interest to technicians and researchers alike (Pisani, 1971; Guerriero and Loreti, 1978; Bargioni *et al.*, 1979) because of the need to rapidly absorb the cost of plant installations by reaching the maximum yield per hectare in as short a period as possible.

This tendency to adopt high-density planting is evident for apples and pears among the pomaceous fruits and for peaches among the drupaceous where from 8 to 10,000 plants/hectare have been planted in a meadow peach orchard (Monastra *et al.*, 1976; Guerriero and Loreti, 1978; Bellini *et al.*, 1980; Bargioni *et al.*, 1984; Recupero *et al.*, 1984). It is not very evident for dry fruits, probably because farmers are less interested in this type of product. Only for the hazel-nut has anyone tried to increase plant density by applying a number of modifications to the traditional methods of planting and growth (Limongelli, 1986). No other trials have been carried out on high-density planting of the almond, and no studies have been done to evaluate the economic advantages.

The present trial was aimed at verifying both the productive response of the three cultivars to unusual plant densities (400 and 800 plants per hectare instead of the 200 to 300 usual for this type of plant) as well as any increase in earnings as a function of higher plant density.

Materials and methods

The trial was carried out, at the Pantanello experimental field station at Metaponto in the Basilicata region (southern Italy). Cultivars Ferragnes, Supernova and Tuono grafted onto seedlings were planted in the winter of 1983-84 in soil which tends to be sandy, rocky (55%), subalkaline, poor in organic substances, nitrogen and potassium, and with average calcium and phosphorous contents.

Up to 1993, the plants were grown in vase form with three branches, at distances of 5x5 m and 5x2.5 m with a density of respectively 400 and 800 plants per hectare. In 1994 half the plants were removed from the orchard planted at 5x5.25 m to obtain an overall 5x5 m.

A split-plot experimental scheme was adopted with four repetitions of ten plants. The data collected each year concerned the trunk section area, weight of pruning wood per plant and yield per plant. Productive efficiency (ratio of cumulated yield per plant to trunk-section area), cumulated yield and pruning wood per hectare were also calculated. Data were analysed statistically by split plot and the differences between the trials tested with the Student-Newman Keuls test with a 95% probability.

Economic differences in planting costs (cost of plants, planting, tutor), training cost (pruning) and profits (earnings multiplied by average annual price of shelled nut at the Bari market) were analysed.

Results and discussion

Data regarding the trunk-section area demonstrate that the plants develop more vigorously at the lower density (5x5 m), with a corresponding increase in pruning wood per plant (Table 1). This confirms that plants reach their full potential better when planted at greater distances.

Comparison of the vegetative parameters expressed by the trunk-section area shows that Ferragnes is the most vigorous cultivar, followed by Supernova and Tuono (Table 1). This can be explained by the vegetative habitus of the three cultivars; in fact, Ferragnes tends to grow higher than the other two. Ferragnes also has the highest weight of the cumulated pruning wood per plant (Table 1).

Table 1. Productive and vegetative parameters of three cultivars planted at two different distances

Cultivar	Distance	Cumulated production per plant (kg)	Cumulated production per hectare (t)	Cumulated pruning wood (kg)	Area of the trunk sector (cm ²)
Supernova	5 x 5	49.5	19.8	83.1	276.2
Supernova [†]	5 x 2.5	30.6	24.5	54.5	209.4
Tuono	5 x 5	58.3	23.3	79.2	245.3
Tuono [†]	5 x 2.5	28.4	22.7	44.4	185.4
Ferragnes	5 x 5	55.3	23.2	113.6	425.1
Ferragnes [†]	5 x 2.5	29.3	23.5	52.3	302.5

[†]Until 1993, after which half the plants were eliminated to obtain a 5x5 m distance

The productive parameters show the same behaviour, with the lower density planting distance (5x5 m) corresponding to a significantly higher production per plant (5.5 kg against 3.1 kg for 5x5.25 m), but the production per hectare is almost the same (Table 2).

Table 2. Statistic analysis of the split plot. Differences subjected to the Student-Newman-Keuls test ($P = 0.95\%$)

	Production per plant (kg)	Production per hectare (t)	Productive efficiency (g/cm ²)	Pruning wood per plant (kg)
Distance				
5 x 5	5.5 ^b	21.3 ^a	187.9 ^a	8.8 ^b
5 x 2.5	3.1 ^a	20.5 ^a	129.5 ^a	5.7 ^a
Cultivar				
Ferragnes	4.2 ^a	21.3 ^a	114.0 ^a	7.8 ^a
Supernova	4.0 ^a	22.7 ^a	163.8 ^b	6.8 ^a
Tuono	4.3 ^a	21.4 ^a	198.3 ^c	7.1 ^a

From Fig. 1 reporting the production per plant it can be seen that the 5x5 m plants produce more quantitatively, although the difference is minor in the initial phase of productivity. However, if we compare the production per hectare shown in Fig. 2, it is higher during the initial years at 5x2.5 m. At the beginning of the sixth year after planting, production per hectare tends to become equal, and once the plants have reached full productivity the difference in yield per surface unit tends to disappear.

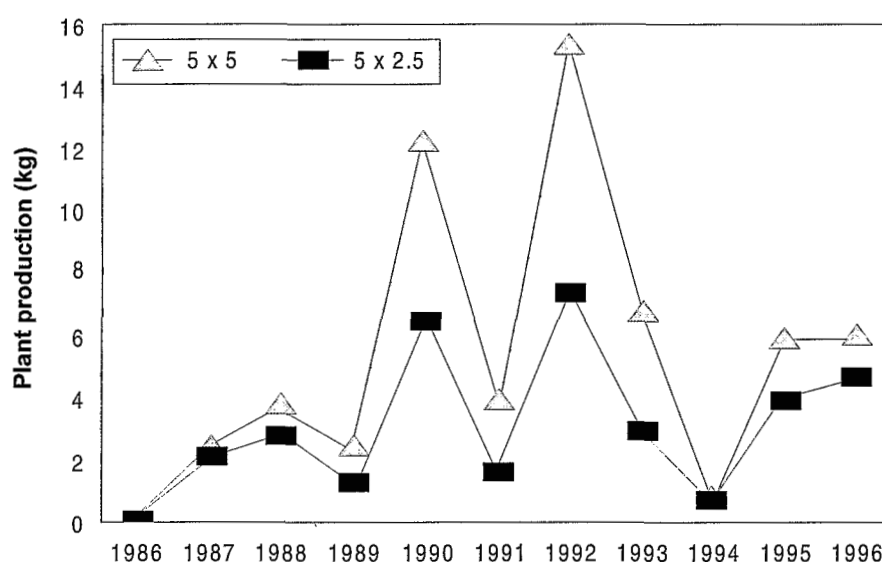


Fig. 1. Planting distances effect on plant production.

No significant difference in yield is found between the three cultivars either per plant or per hectare. Tuono is the most productive cultivar at 5x5 m (58.3 kg of cumulated production per plant), followed by Ferragnes and Supernova, which seem, on the contrary, to better exploit the reduced planting distance (30.6 kg) (Table 1). Nevertheless, productive efficiency decreases significantly from Tuono (198.3) to Ferragnes (114), which could be correlated to an increase in vegetative vigour.

The economic cost at the end of ten years of production was slightly higher for high-density planting, mainly due to higher installation costs (3,150\$ for 5x2.5 m vs 1,575\$ for 5x5 m) as well as to higher management costs (the difference in the first five years was about 700\$).

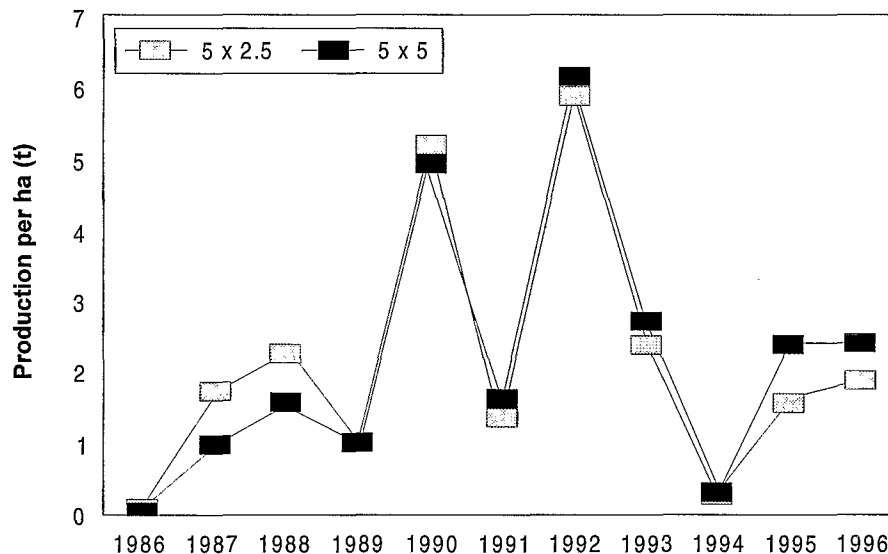


Fig. 2. Planting distances effect on production per hectare.

The higher cost was not compensated for by the increased profit of the first years of production (7,655\$ for 5x2.5 m vs 4,675\$ for 5x5 m). From the fifth year on, a better profit was obtained with the lower density planting (22,200\$ for 5x5 m vs 19,500\$ for 5x2.5 m).

The total earnings after 10 years of production were 26,875\$ from the 5x5 m orchard and 27,155\$ from the 5x2.5 m.

Conclusions

It has been demonstrated that plants planted at a smaller distance (5x2.5 m) begin production earlier and have a higher yield per hectare in the first years. However, at the fifth year, when the plants enter their phase of full production, a greater distance (5x5 m) between plants results in higher production, which tends to equal and then exceed the results obtained from the higher density plants.

As for cumulated production, Supernova is more productive at smaller distances and Tuono has the highest production per plant (but without statistical evidence).

Economic analysis demonstrates that in spite of higher earnings, and considering the higher cost of implementation, reduced plant distance is neither economically nor agronomically advantageous compared with other plant species.

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