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STIONIC COMBINATIONS AND ORGANIC MANURE EVALUATION IN A 'FUERTE' AVOCADO ORCHARD AT BNEI-DROR, ISRAEL*

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Abstract

The Bnei-Dror avocado orchard, planted in 1969 on sandy-loam and designed as a factorial experiment, included five stionic combinations and three fertilization treatments. The experiment lasted 10 years, during which seven crops were harvested. Vegetative development data of the trees were obtained by measuring the projection area of the tree canopies by means of aerial photography.

The results of the experiment show very clear effect of scion produced about 30% higher crop than the other one, Nabal rootstock induced the grafted trees to produce additional yield of about 56% relative to two Mexican rootstocks. The response to manuring was a 50% yield increase. The combined effect of good rootstock and organic manure was increase production of 135% relative to the alternative factor combinations (two combinations, with a common source of scion).

The stionic combination effect was more or less uniform throughout the investigated period, while the manure effect was stronger in poor years.

Trees grafted on Nabal rootstock developed faster, while one of the Mexican rootstocks had clear dwarfing effect. These facts did not influence the order of merit of the combinations, based on yield per tree area. The manured trees, although found to be better bearers, were not bigger in size.

Organic manure increased the leaf content of nitrogen, phosphorus, and potassium, while Nabal rootstock increased the leaf content of ash, calcium, and magnesium.

The populations of the different combinations were found to differ in diversity as well as in the distribution curves. Some excellent trees were chosen for clonal duplication. Some characteristics of Nabal rootstocks are discussed, as well as the effects of manure.

The idea that organic manuring is an important treatment for avocado orchards, and is not replaceable by chemical fertilization, is examined in this article. Theoretically, the nutrients contained in organic manure could be replaced by fertilizers, but the advantage of the manure is the gradual decomposition process resulting in a steady, continuous supply. This slow release could eliminate the leaching of the elements to the subsoil, which results in pollution of underground water and a loss of resources. Another advantage of the manure as a supplier of elements is its richness in variable components, some of them of an organic character, which could be essential for the avocado even if the lack of them was not recognized. Organic manure also supports biological activities in the rhizosphere, including mycorrhiza. This is especially important for a plant such as avocado, which does not have root hairs[6]. Soil physical characteristics can be improved by organic material, which can induce better aeration in heavy, compact soils and enhance the retention of water and elements in light soils[13]. In recent years, organic matter has become an important component of the holistic approach which was developed in Australia and adopted in California[7] for root rot control. Everywhere, when soil conditions are not favorable for the avocado root system, the presence of organic matter, including compost, as a mulch enables roots to develop above the soil and to extend into the mulch layer, where they find better conditions.

In the past, as in the case of many other crops, avocado growers used to supply organic manure to their orchards. Popenoe (1920) mentioned the use of cattle organic manure as nitrogen supplier for California orchards, and as an ammonia supplier in Florida. But in California, the manure supply was limited and expensive, and in the course of time, since its necessity was not proven (Embleton & Jones)[8], its use became rare. Apart from Embleton's experiments, very little has been done during the years to evaluate the use of organic manure for avocado, especially in regard to productivity. In Israel, the use of organic manure as a mulch or under ridges while they are established, is found to be helpful in regard to trees' condition. Before organic manure treatment was given, trees degenerated by lack of aeration[1 & Ben-Ya'acov, unpublished data]. In another experiment[9], the use of fresh manure resulted in chlorosis and reduced productivity.

In the present article, the use of organic manure on light soils, after composting, will be described. The experiment is part of rootstock-scion research program described previously[2]. The experimental design as split plots enabled the involvement of agrotechnical means of evaluation in factorial experiments.

Materials and methods

The Bnei-Dror orchard used in the experiment was planted on sandy loam soil in the fall of 1969. Fifteen plots were designed, each of them containing 20 trees, with bordering rows between them. The 20 trees comprised five stionic combinations, with four trees of each combination. These combinations enabled comparison of rootstocks grafted with 'Fuerte' scions from the same sources and scions from different sources when they were grafted on the same rootstock.

The manuring part of the factorial experiment included three treatments: 1) organic manure and nitrogen fertilization, 2) organic manure only, and 3) nitrogen fertilization.

Nitrogen fertilization was given as ammonium nitrate—0.5 kg/tree until 1971, and 1 kg/tree until 1974. Then we learned that the nitrate content of the water was equivalent to as much as 180 kg fertilizer/acre, so the use of this fertilization was discontinued.

Table 1. Organic manure composition calculated on a dry weight base.

Organic matter (%)	Ash (%)	SiO_2 (%)	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Na (%)	Cl (%)	B (ppm)	Fe (ppm)	Zn (ppm)	Mn (ppm)
13.8	86.2	78.4	0.55	0.27	0.59	1.93	0.28	0.114	0.25	13	4550	45	168

Table 2. Data collected at the Bnei-Dror 'Fuerte' experiment, planted 1969

	Scion	treatment (1) rootstock	Accumulated yield (2) k/tree O + F	O	F	Mean	O treatment additional yield % (3)
	Nordia 22	Nabal	254.0	283.3	174.3	237.2 a	62
	Nordia 30	APAM 18	203.5	220.5	161.2	195.1 ab	37
	Nordia 20	Nabal	225.9	191.3	127.5	181.6 b	50
	Nordia 22	APAM 23	164.3	175.9	125.3	155.2 b	40
	Nordia 22	APAM 22	134.3	192.3	120.8	149.1 b	59
Average for treatment			196.4 a	212.7 a	171.8 b		50
Tree's area (m^2), 1975			18.5	16.7	17.3		
Trunk circumference growth 1973-1966 (cm)			26.2	26.3	28.4		
Yield/unit area (kg/m^2)			10.6	13.1	8.6		

(1) Treatment: O=Organic manure; F=Nitrogen fertilization (see text). Different letters indicate significant differences among values on the $P<0.05$ level (0.07 in regard to treatment)

(2) Accumulated yield until the 10th year of the orchard.

(3) Additional yield of O treatment was calculated relatively to F treatment.

The organic manure was treated by the orchard workers, who converted the heap a few times until it was ready for use; its composition *is* presented in **Table 1.** In the first 2 years, the organic manure was buried in trenches near each tree, with an individual treatment of 40 l/tree, to a depth of 30 cm. Later, the manure treatment was given mechanically at 20 m^3 per acre in each treatment in 1972, 1973, 1974, 1976, and 1978;

all treatments were given in May. The monitoring of the experiments was based on methods used in the experimental system and described elsewhere (Ben-Ya'acov submitted for publication).

Results

The orchard developed slowly owing to the low fertility of the soil.

Yields: The accumulated yields until 1979, the 10th year of the orchard, are presented in **Table 2.** Scions from two sources were compared, grafted on Nabal rootstock: Nordia 22 produced significantly better than Nordia 20, with about 30% greater yield. Three rootstocks grafted with the scion Nordia 22 were compared: Nabal rootstock improved the productivity of the grafted tree significantly relative to two Mexican rootstocks, with about 56% additional yield. Organic manure with or without fertilizer, improved productivity by about 50% relative to unmanured trees.

Vegetative growth: Manured trees developed more slowly than trees that received fertilizer, according to two criteria: canopy projected area and additional growth of trunk circumference.

Tree efficiency: Calculation of yield/unit area showed a great advantage of manured trees, relative to the other treatments, especially the unmanured trees.

Discussion

Under the local conditions of the Bnei-Dror orchard, the three investigated factors—scion, rootstocks, and mature— had considerable and significant effects on 'Fuerte' avocado productivity. With a common source of scion, the combined effects of manure and the better rootstock improved productivity by as much as 135% relative to unmanured trees grafted on the inferior rootstocks (7-year accumulated yields of 283 and 121 kg/tree respectively).

The order of merit among stionic combinations was similar under different fertilization regimes, while the greater yield achieved with organic manure than with chemical fertilizer depended on the stionic combination, and was in the range of 37-62%. The maximum additional yields were achieved by giving manure to the best and worst stionic combinations.

The advantage of Nabal rootstock relative to Mexican rootstock, with regard to productivity of the grafted trees, had been determined in a previous experiments[10], but those results apply only to non—calcareous soils. Differences in productivity among sources of 'Fuerte' scion have also been described in the literature[3].

The main aim of the present paper is to describe the effect of manure on 'Fuerte' growth and productivity; in the background section, past experience and organic matter characteristics were discussed. In a recent article, Bergh[5] expressed his confident belief that a supply of organic matter is essential for the avocado; but he presented no evidence for this idea. In Israel, Oppenheimer (personal communications) has expressed the same belief many times, but did not find any relevant data to be included in his book[11].

The Bnei-Dror experiment is probably the only one to demonstrate the possible magnitude of the positive effect of compost on avocado productivity over a long period. The additional yield of 50% on the average, or of 37-62% in various stionic combinations justifies the appropriate periodic application of manure in considerable quantities. We would like to recommend a supply of 20 m^3 (about 15 tons) per acre, every second year.

We lack sufficient data to understand what were the manure characteristics by which the productivity was increased by 50% without any increase in tree dimensions. We know that the soil type in the orchard was light with low capacity for water and elements, which was probably increased by the manure. In leaf composition analyses carried out every year, we found that the manure increased the leaf content of NPK considerably. On the other hand, the leaf contents of the same elements in the control trees (fertilization only) was optimal, and no deficiency symptoms were discovered.

As a practical conclusion of the Bnei-Dror experiment, we recommended the use of Nordia 22 scion and Nabal rootstock for planting in similar conditions and of organic manure in a compost form in periodical treatments.

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