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EFFECT OF BIOFERTILIZATION ON REDUCING CHEMICAL FERTILIZERS, VEGETATIVE GROWTH, NUTRITIONAL STATUS, YIELD AND FRUIT QUALITY OF ARABI POMEGRANATE TREES.

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ABSTRACT

This study was carried out during 2004 and 2005 seasons on eight years old Arabi pomegranate trees grown in sandy soil to investigate the influence of microbial biofertilization on tree growth, yield, fruit quality and leaf minerals content. Microbial inoculum (Azotobacter spp. Azospirillum spp. and Bacillus megatherium which found in (Biogein, Nitrobine, phosphorein), in addition, arbuscular mycorrhizal (AM) fungi were used to reduce the recommended dose of nitrogenous and phosphoric fertilizers of the trees. The treatments were 100 % of recommended mineral fertilizers dose / tree without microbial biofertilization (control) and 100% (T_1), 75 % (T_2), 50% (T_3) and 25% (T_4) of recommended mineral fertilizers dose plus microbial fertilizers. Data revealed that shoot length, leaf area, leaf dry weight and leaf chlorophyll of treated trees with microbial fertilization were significantly increased compared with uninoculated control trees. Also, leaf total carbohydrates content recorded significant increases compared with the uninoculated control.

All microbial fertilization treatments markedly affected nutritional status of Arabi pomegranate trees, leaf concentrations of N, P, Ca, Fe and Zn were significantly increased. While, Mg and Mn concentrations were consistently higher without significant difference in comparison with control.

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Microbial biofertilizers significantly increased yield parameters (number and weight) and fruit quality. T_1 and T_2 treatments recorded the highest fruit weight and number per tree. At the same time, T_2 recorded the highest average fruit weight, length and width; moreover, it significantly improved TSS %, acidity % and anthocyanin content of fruit juice at harvest time in both seasons. Also, T_2 improved V.C content and decreased tannins % of fruit juice without significant difference in comparison with control. So, the recommended treatment is T_2 which contained microbial biofertilization + 75 % of recommended mineral fertilizers and reduced about 25% of the recommended mineral fertilization

INTRODUCTION

Pomegranate (Punica granatum, L) has been mentioned in the Holy Quran and it was cultivated in Egypt long time ago. It is a popular fruit of tropical and subtropical regions and considered one of the most valuable fruits for its nutritive, industrial and medicinal values. (Swain, 1965, Sharaf *et al.*, 1967and Nasacheva, 1973). The total cultivated area of pomegranate is 4496 feddan with total fruit production of 24881 metric tons, according to the latest statistics of the Ministry of Agriculture and Land Reclamation (2004). This area is mainly concentrated in Upper Egypt.

Although, pomegranates occupy a small acreage of the total area cultivated with fruit trees, most of the newly reclaimed soils are extensively planted with such fruits that may tolerate stress conditions. So, suitable fertilization programs are needed in order to improve the growth and productivity of this fruit (Haggag and El –Shamy, 1987)

Fertilization is considered an important practice during the growing season to obtain an economic yield and to improve the fruit quality characters. In Egypt, most growers usually apply mineral fertilizers in large quantities, especially nitrogen fertilization.

Mineral fertilizers and other chemicals commonly used in agricultural production not only have harmful effects on the environment, but also they can alter the composition of fruits, vegetables and root crops and decrease their contents of vitamins, minerals and other useful compounds. Also, there is a very great danger that harmful residues may remain in food. (Bogatyre, 2000).

Using biofertilizers can be considered as an appropriate method to overcome these problems. They mainly comprise different organisms which may affect their host plant by one or more mechanisms, such as nitrogen fixation, production of growth promoting substances or organic acids, enhancing nutrient uptake or protect against plant pathogens (Samah, 2002).

Biofertilizers are very safe for human, animal and environment. They are biological preparations containing primarily potent strains of microorganisms in sufficient numbers. These microorganisms have definite beneficial roles in the fertility of soil rhizosphere and the growth of the plants. Biofertilizers proved to eliminate the use of pesticides sometimes, and rebalance the ratio between plant nutrients in the soil. They are easy and safe to handle with field applications. They also increase crop yields and decrease the cost of some agricultural practices (Ishac, 1989 and Saber, 1993).

Accordingly, the biological fertilizers have a growing importance over the chemical fertilizers from the stand point of environmental safety, quality of fruits and sustainable agriculture. Recently, several studies were carried out on the dual inoculation of different plants with nitrogen fixers and arbuscular mycorrhizal (AM) fungi (Rahman and Parsons, 1997; Amora-lazcano *et al.*, 1998 and Bethlenfalvy *et al.*, 1999).

In poor P sandy soils, like Egyptian ones, the soluble phosphate is derived from either organic matter or applied as mineralized phosphate fertilizers such as superphosphate and orthophosphoric acid. Graham and Timmer (1985) reported that no further P fertilizers may be necessary if rock phosphate and arbuscular mycorrhizal (AM) fungi inoculum are incorporated into media. Several studies reported that infection of plant roots by arbuscular mycorrhizal (AM) fungi enhanced element uptake,

water uptake and growth. Otherwise, AM fungi have come to be viewed not only as plant symbionts, but as symbionts of both plant and soil (Rahman and Parsons, 1997).

The aim of this work was to study the effect of substituting a part of chemical nitrogenous and phosphoric fertilizers by suitable microbial fertilizer on tree growth, yield, fruit quality and leaf minerals content of Arabi pomegranate trees.

MATERIALS AND METHODS

This investigation has been carried out during 2004 and 2005 growing seasons on eight years old "Arabi" pomegranate trees. The trees were grown in a private orchard, located at Ismailia – Cairo desert road and planted in a sandy soil at 4X6 meters apart. Physio-chemical properties of the soil are shown in Table (1). All trees were subjected to the common horticultural practices of the region. Microbial inoculum consisted of bacterial types of symbiotic nitrogen fixers (Azotobacter chroococcum and Azospirillum barasilense) which found in two microbial biofertilizers: Biogein and Nitrobine. In addition to the third biofertilizer phosphorein, which contains phosphate dissolving vesicular (Bacillus megatherium) and silicane bacteria, and arbuscular mycorrhiza. Azotobacter spp. found in the microbial inoculum with density about $1X10^8$ (CFU/g of inoculum); and Bacillus megatherium with cells density about $2x10^8$ (CFU/g of inoculum). The microbial biofertilizers are produced and purchased from the Biofertilizers Unit, ARC, Ministry of Agriculture and Land Reclamation.

Inoculation of trees was applied at the end of February in four holes (5cm wide and 3 cm in depth) of soil per tree. Each tree (T_1 to T_4) received 20 gm of the used microbial biofertilizers (Biogein + Nitrobine + Phosphorein + arbuscular mycorrhizal fungi).

Fifteen trees, as uniform as possible, were selected for this study and received the following treatments:-

1- C: Control trees received the recommended doses of chemical fertilizers (1.0Kg ammonium sulphate + 1.0 Kg calcium super

phosphate +1.0 Kg potassium sulphate per tree/season) without any microbial inoculation.

2- (T_1): Trees were microbial inoculated and received 100% of the recommended doses of chemical fertilizers.

3- (T_2): Trees were microbial inoculated and received 75% of the recommended doses of chemical fertilizers.

4- (T_3): Trees were microbial inoculated and received 50 % of the recommended doses of chemical fertilizers.

5- (T_4): Trees were microbial inoculated and received 25% of the recommended doses of chemical fertilizers.

These treatments were arranged in a Randomized complete Block Design (R.C.B.D.) and each treatment was replicated three times with one tree in each replicate.

The following parameters were recorded and calculated in both seasons:

Vegetative growth:

Three branches in different directions on each tree were selected and labeled to estimate growth parameters. Shoot length (cm) of all current shoots that developed on these branches were measured. At the end of both growing seasons, ten leaves were collected randomly from the first fully mature leaves from the tip of the previously tagged shoots and their areas were measured using a planimeter.

On July 30 of both seasons, samples of 30 leaves were collected randomly from the first fully mature leaves from the tip of the previously tagged shoots from each replicate to determine the leaf constituents (Reisenauer, 1978). Leaves were washed with tap water, rinsed with distilled water, dried at 70°C in oven until constant weight and then ground.

Total leaf chlorophyll content: was determined in fresh leaf samples according to the method described by Yadava (1986) using Minolta Chlorophyll METER SPAD – 502 (Minolta camera, LTD JAPAN).

Leaf minerals content: A sample of 0.3g from the ground material was digested with sulphuric acid by hydrogen peroxide according to Evenhuis and Deward (1980). Total nitrogen and phosphorus were colorimetrically

determined according to Evenhuis (1976) and Murphy and Riley (1962), respectively. Potassium was determined by a Flame photometer (Jackson, 1967). Calcium and magnesium by titration with the versenate method as described by Cheng and Bray (1951). Iron, zinc and manganese were determined by Perkin- Elmer Atomic Absorption Spectrophotometer Jackson and Ulrich (1959).

Leaf total carbohydrates: were determined as percentage on dry weight basis according to Dubois *et al.*, (1956).

Yield and fruit quality: At harvesting time, on August 30th, in both seasons, total yield was recorded (as fruit number and fruit weight kg/tree). Five fruits were taken randomly from each tree to determine fruit quality (average fruit weight (g), fruit length (cm) and width (cm)). In fruit juice of each fruit simple total soluble solids (TSS) percentage was determined by a hand referactometer, acidity and vitamin C contents as (mg V.C /100ml juice) were determined according to the (A.O.A.C.1980). Also, total anthocyanin content in fruit juice was determined as described by Hsia *et al.*, (1965). Tannins content was measured in the juice by the method described by (Winton and Winton, 1945).

Data were statistically analyzed according to Snedecor and Cochran (1990) and L.S.D. test at 0.05 levels was used for comparison between treatments.

RESULTS AND DISCUSSION

Vegetative growth:

Data in Table (2) indicated that all the studied parameters of vegetative growth were influenced by microbial biofertilizer treatments. All microbial biofertilization treatments increased significantly shoot length when compared with the control trees. The data also cleared that, there was a direct proportional relation between the amount of the applied recommended mineral fertilizer and shoot length. In this respect, as the amount of mineral fertilizer increased, shoot length increased. Statistical analysis showed that differences were significant among all treatments in

both seasons of study. Similar trend was also observed with leaf area and leaf dry weight with one exception in the first season. The increase in those parameters could be explained by the fact that asymbiotic nitrogen fixers (ANF) have the capability to fix atmospheric nitrogen (Nijjar, 1990) which could be used in tree growth and development of its structure. These results are in harmony with those were obtained by Abo-Taleb *et al.*, (1999) on pomegranate, El-Sayed, (2002), Ahmed *et al.*, (2003) and Abd El – Hady, (2003) on grape, El- Sharkawy and Mehaisen, (2005) on guava and Ibrahim *et al.*, (2005) on "Canino" apricot. They all reported that, microbial fertilization led to a great promotion in all plant characters. It was also reported that inoculation with arbuscular mycorrhizal (AM) fungi had a beneficial effect on plant growth. These results are in line with those reported by (Yamashita *et al.*, 1998) on "Black Olympia" grape and Gabr and Nour El- Dein (2005) on apple.

Leaf chlorophyll content:-

The results presented in Table (2) indicated that total chlorophyll content of Arabi pomegranate leaf was significantly affected by the application of biofertilizer than traditional control trees. Trees treated with microbial biofertilizer and received 100 % of recommended mineral fertilization doses (T_1) had the highest leaf chlorophyll content followed by those received microbial biofertilization + 75 % of recommended mineral fertilizers (T_2). While, trees received microbial biofertilization + 25 % of recommended mineral fertilizers recorded the lowest values irrespective the control. Statistical analysis showed that differences were significant among treatments and between treatments and control with exception between T_1 and T_2. These findings are confirmed by the results obtained by Abo-Taleb *et al.*, (1999) on pomegranates; Mahmoud and Mahmoud (1999), on peach; Ibrahim *et al.*, (2005) on "Canino" apricot and Gabr and Nour El-Dein (2005) on apple.

So, we can attribute the superiority of microbial biofertilization treatments in increasing leaf chlorophyll content of Arabi pomegranate to the influence of nitrogen fixers bacteria. These strains of bacteria have capability to fix atmospheric nitrogen in a continuous release manner.

This nitrogen was utilized by the tree to synthesize chlorophyll molecules of leaves (Devlin, 1972). In other viewpoint, increasing chlorophyll content, which has an active role in forming plastid pigments in plant cells; plays an important function in photosynthesis process and production of carbohydrates (Mengel and Kirkby, 1987). Also, phosphate dissolving bacteria combined with arbuscular mycorrhizal (AM) fungi may have released phosphorus ions that effectively acquired and taken up by the trees.

Leaf total carbohydrates content:

Data recorded in Table (2) exhibited the influences of microorganisms addition on carbohydrates content of "Arabi" pomegranate leaves. In the first season, microbial inoculum significantly increased leaf content of total carbohydrates than non–inoculated (control) ones. In this concern, the highest leaf content of total carbohydrates was obtained from trees treated with microbial biofertilizer and received 100 % of the recommended mineral fertilization doses (T_1) followed by (T_2). On the other hand, the lowest values were obtained from the control ones. The obtained results are in agreement with those concluded by Gabr and Nour El- Dein (2005) on apple. They found that mycorrhizal inoculation increased leaf and root sugars and carbohydrates concentrations in comparison with non infected control. Also, Shrestha *et al.*, (1995) observed that photosynthesis and transpiration rate of AM-inoculated trees were greater than those of non–AM ones.

Leaf macro-elements content:

Data of microbial biofertilization influences on macroelements content of "Arabi" pomegranate leaves were presented in Table (3). Data showed that microbial inoculum significantly increased N and P leaf contents than uninoculated control ones. The highest N and P concentrations were recorded from trees treated with microbial biofertilizer and received 75% of the recommended mineral fertilizers doses (T_2) followed in a descending by T_1, T_3, T_4 and C. Similar results were previously observed by Abd El–Hady (2003) on Flame seedless grapevines, El-Sharkawy and Mehaisen, (2005) on guava and Ibrahim et al., (2005) on apricot. They concluded that microbial biofertilizers

increased N content. This increment may be due to the action of biofertilizer that converts gaseous atmospheric nitrogen to available form for plants.

Numerous investigations demonstrated that mycorrhizae inoculum gave the best improvement in growth and nutrition, resulting in higher shoot P contents of different fruit species as well as stimulated the root of trees to release acid phosphatase into soil which led to increased P soil content and leaf P concentration El-Sharkawy and Mehaisen, (2005), on Ettmani guava, Ibrahim *et al.*, (2005) on Canino apricot and Gabr and Nour El-Dein (2005) on Anna apple.

The present explanation is strengthened by the findings of Toro *et al.*, (1997) which concluded that rhizobacteria works as mycorrhizae helper bacteria promoting establishment of both the indigenous and introduced arbuscular mycorrhizae endophytes. They also stated that using rhizobacteria may have released phosphate ions which may be effectively taken up through the external arbuscular mycorrhizae mycelium.

Concerning data of "Arabi" pomegranate leaf content of K, Ca and Mg elements as affected by biomicrobial fertilizer, it is obvious that, K and Ca concentrations of the inoculated trees were significantly increased in comparison with non–inoculated (control) although differences among treatments were not significant. No significant differences were found in leaf Mg content between the treatments and control. The present data support the findings of Gabr and Nour El-Dein (2005) which concluded that increasing colonization of roots by AM fungi was accompanied by increment in the concentration of K than the control. Also, El–Sharkawy and Mehaisen, (2005) on guava, Ibrahim *et al.*, (2005) on apricot and Rania, (2005) on grapes concluded that microbial biofertilizers increases K content in the leaves. While, Tang *et al.*, (1989) reported that, autoradiograms indicated that mycorrhizal infection of trifoliate orange and "Goutou" sour orange enhanced Ca^{45} absorption and transport to the upper part of the plant as a result, total calcium content was significantly higher in mycorrhizal infected seedlings.

In general, inoculation with microbial biofertilizer in sandy soil of the present study increased soil microbial diversity, density and activity resulted in more suitable condition for nutrients release in the rhizosphere and nutrients uptake by tree roots. This is the direct reason of increasing leaf content of nutrient elements in the present study as a result of microorganisms addition.

Leaf micro-elements content:

Data presented in Table (4) indicated that control trees significantly decreased leaf Fe and Zn concentrations in comparison with inoculated trees with microbial biofertilizer. Statistical analysis exhibited that differences among treatments were not significant, wherever between treatments and control turned to a significance manner. At the same time, Mn determinations did not record any significant differences among treatments or between treatments and control. These results coincide with the findings of Gabr and Nour El-Dein (2005) who reported that the increased colonization of apple roots by AM fungi was accompanied by a significant increase in the concentrations of Fe and Zn but Mn concentrations. Also, Ahmed *et al.*, (2003) reported that microbial biofertilizers increased Fe and Zn leaf content of Flame seedless grapevines.

Generally, suggesting role for mycorrhiza in host nutrient allocation, the influences of biomicrobial fertilizers in increasing leaf content of nutrient elements could be discussed in light of findings of Singh and Kapoor, (1999) who concluded that release of organic and inorganic acids and increasing O_2 evolution due to phosphate dissolving microorganisms and other microbial types reduce soil pH, leading to change of nutrients to available forms ready for uptake by plants. Moreover, Singh and Kapoor, (1999) suggested that plant hormones released by microorganisms increase plant root growth causing in turn increasing plant root surface which improves nutrient absorption.

Yield and physical fruit quality:

The effect of microorganisms biofertilizer on yield of Arabi pamegranate trees is shown in Table (5). It is clear that all the studied parameters of yield were significantly increased as biofertilizer was

applied to trees when compared with uninoculated controls. In the meantime, all treatments had similar effect on fruit weight per tree and fruit number per tree in both seasons. These results are in accordance with those previously reported by Kamelia *et al.*, (2000) and Rania (2005) on grapes and Gabr and Nour El–Dein (2005) on apple.

Concerning fruit quality characteristics, the data in Table (5) cleared that, T_1 and T_2 recorded the highest average fruit weight followed by T_3 then T_4 in the first season. While, in the second one, T_2 had the highest fruit weight. At the same time, T_2 markedly increased fruit length in both seasons, and fruit width in the second season only. These results are in line with Al- Khayat and Al-Diyaili (2001) and Rania (2005).

Chemical fruit quality:

Chemical fruit quality characters of "Arabi" pomegranate fruits were improved by microbial inoculation Table (6). Treatments of T_1 and T_2 increased significantly TSS % of fruit juice in the first season and T_2 showed similar trend in the second one. While, acidity % and tannins % of Arabi fruit juice decreased by microbial biofertilization treatments in both seasons. Significant decrease was only found for acidity. In the meantime, using microbial biofertilization did not affect vitamin C contents. The first treatment had a slight increase in V.C content in both seasons. The obtained data are confirmed with report of Shrestha *et al.*, (1996) and Gabr and Nour El-Dein (2005). They found that, inoculated Satsuma mandarin and "Anna" apple with AM fungi had better fruit quality than non inoculated control trees. The fruits of inoculated trees were larger, had higher juice sugar contents and better peel color than the controls. Also, Abo-Taleb *et al.*, (1999); on pomegranate, Attala *et al.*, (2000) on pears and Ibrahim et al., (2005) on apricot concluded that microbial bioferilizers increased yield and improved physical and chemical quality characteristics of different fruits.

In general, we can attribute the superiority of microbial fertilization treatments of enhancing fruit yield and quality of "Arabi" pomegrante trees to the improving and activating physiological status of whole tree by microorganisms. Related obtained data exhibited the influences on vegetative growth especially leaf area, chlorophyll

concentrations, which in turn increased carbohydrates and such like photosynthesis, leaf nutrient elements concentrations. This explanation found support through findings of Dixon (1995) which disclosed that AM colonization increased cytokinin activity of citrus roots and leaves, photosynthesis and transpiration rate (Shrestha *et al.*, 1995), increased enzymes (polyphenol oxidase) activity, which in turn positively affected fruit yield and quality.

Finally, it could be concluded that the most effective treatment is T_2 which contained microbial biofertilization + 75 % of the recommended mineral fertilizers. Hence it could be noted that using T_2 can save about 25 % of mineral fertilizers dose.

Table (1): Soil chemical and physical properties of the experimental orchard.

Soil depth (cm)	pH	EC dsm^{-1}	Soluble Cations				Soluble Anions			$CaCO_3$	Gravel	Sand	Silt	Clay	Texture
			Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-2}	SO_4^{-2}	%	%	%	%	%	
00-30	8.1	0.49	1.3	0.6	2.9	0.1	0.9	3.0	1.0	3.5	0.80	96.23	1.12	1.85	sandy
30-60	8.1	0.25	0.7	0.4	1.3	0.1	0.6	1.2	0.7	2.8	1.10	95.24	1.06	2.60	
60-90	8.1	0.28	0.9	0.3	1.5	0.1	0.7	1.4	0.7	2.7	1.15	94.60	1.55	2.70	

Table (2): Effect of microbial biofertilization on vegetative growth, leaf total chlorophyll and carbohydrates of "Arabi" pomegranate trees during 2004 and 2005 growing seasons.

Treatments*	Shoot length (cm)		Leaf area (cm^2)		Leaf dry weight (gm)		Total chlorophyll mg/cm^2		Total carbohydrates %	
	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
C	26.23	30.50	3.38	3.66	2.32	2.34	5.30	5.52	10.80	10.93
T 1	61.31	63.00	6.15	6.16	2.64	2.73	6.98	7.02	12.95	12.90
T2	52.71	54.00	5.58	5.60	2.64	2.71	6.86	6.93	12.85	12.95
T3	44.10	46.15	4.90	5.00	2.60	2.63	6.22	6.18	11.88	11.83
T4	35.36	38.00	3.90	4.40	2.55	2.50	5.85	5.91	11.44	11.50
L.S.D at	6.11	7.34	0.31	0.38	0.25	0.18	0.41	0.35	0.54	0.57

*: C: Control (received the recommended mineral fertilization doses) – T_1: microbial biofertilization + 100 % of recommended mineral fertilization doses – T_2: microbial biofertilization + 75 % of recommended mineral fertilization doses– T_3: microbial biofertilization +50 % of recommended mineral fertilization doses – T_4: microbial biofertilization + 25 % of recommended mineral fertilization doses.

Table (3): Effect of microbial biofertilization on macro-elements content of "Arabi" pomegranate leaves during 2004 and 2005 seasons.

Treatments*	Macro – elements % on dry weight									
	N %		P %		K %		Ca %		Mg %	
	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
C	1.55	1.51	0.14	0.16	0.85	0.89	1.14	1.20	0.24	0.25
T 1	2.24	2.42	0.22	0.25	1.09	1.14	1.27	1.35	0.25	0.26
T 2	2.53	2.60	0.24	0.25	1.11	1.13	1.27	1.37	0.27	0.26
T 3	2.05	2.11	0.20	0.21	1.02	1.06	1.30	1.57	0.25	0.25
T 4	1.84	1.88	0.19	0.20	1.01	1.03	1.35	1.66	0.25	0.25
L.S.D at	0.19	0.17	0.04	0.04	0.11	0.13	0.12	0.14	NS	NS

*: C: Control (received the recommended mineral fertilization doses) – T_1: microbial biofertilization + 100 % of recommended mineral fertilization doses – T_2: microbial biofertilization + 75 % of recommended mineral fertilization doses– T_3: microbial biofertilization +50 % of recommended mineral fertilization doses – T_4: microbial biofertilization + 25 % of recommended mineral fertilization doses.

Table (4): Effect of microbial biofertilization on micro-elements of "Arabi" pomegranate leaves during 2004 and 2005 seasons.

Treatments*	Micro – elements (ppm on dry weight)					
	Fe		Zn		Mn	
	2004	2005	2004	2005	2004	2005
C	100	101	31	34	24	25
T 1	111	110	36	39	26	26
T2	108	112	38	39	26	27
T3	110	111	36	37	25	26
T4	110	111	35	38	25	26
L.S.D at 0.05	7	8	3	3	NS	NS

*: C: Control (received the recommended mineral fertilization doses) – T_1: microbial biofertilization + 100 % of recommended mineral fertilization doses – T_2: microbial biofertilization + 75 % of recommended mineral fertilization doses– T_3: microbial biofertilization +50 % of recommended mineral fertilization doses – T_4: microbial biofertilization + 25 % of recommended mineral fertilization doses.

Table (5): Effect of microbial biofertization on yield and some physical fruit quality parameters of "Arabi" pomegranate trees during 2004 and 2005 seasons.

Treatments*	Number of fruits/ tree		Fruit weight/tree		Average fruit weight		Fruit length		Fruit width (cm)	
	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
C	261.8	265.1	48.3	49.1	176.1	178.5	5.43	5.48	5.03	5.19
T 1	295.1	301.8	57.5	58.1	193.5	190.0	6.71	6.93	6.42	6.50
T2	299.9	298.5	59.5	58.0	193.1	195.2	6.75	6.95	6.42	6.54
T3	275.4	276.0	55.1	55.7	185.0	188.9	5.80	6.83	5.75	6.00
T4	269.3	270.0	54.0	54.5	182.1	183.1	5.63	5.94	5.39	5.45
L.S.D at	31.5	33.1	5.0	5.2	9.5	10.3	0.18	0.21	0.26	0.22

*: C: Control (received the recommended mineral fertilization doses) – T_1: microbial biofertilization + 100 % of recommended mineral fertilization doses – T_2: microbial biofertilization + 75 % of recommended mineral fertilization doses– T_3: microbial biofertilization +50 % of recommended mineral fertilization doses – T_4: microbial biofertilization + 25 % of recommended mineral fertilization doses.

Table (6): Effect of microbial biofertilization on chemical fruit quality parameters of "Arabi" pomegranate trees during 2004 and 2005 seasons.

Treatments*	TSS %		Acidity %		V.C mg/ 100 ml juice		Total anthocyanin %		Tannins %	
	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
C	8.52	8.21	0.58	0.55	2.13	2.32	0.337	0.341	2.52	2.35
T 1	9.88	9.22	0.51	0.40	2.19	2.35	0.371	0.364	2.39	2.30
T2	9.86	10.01	0.50	0.42	2.19	2.33	0.369	0.366	2.49	2.30
T3	8.65	9.20	0.53	0.46	2.18	2.32	0.365	0.345	2.50	2.31
T4	8.60	8.32	0.52	0.51	2.17	2.31	0.341	0.344	2.50	2.33
L.S.D at 0.05	0.15	0.17	0.02	0.02	NS	NS	0.030	0.020	NS	NS

*: C: Control (received the recommended mineral fertilization doses) – T_1: microbial biofertilization + 100 % of recommended mineral fertilization doses – T_2: microbial biofertilization + 75 % of recommended mineral fertilization doses– T_3: microbial biofertilization +50 % of recommended mineral fertilization doses – T_4: microbial biofertilization + 25 % of recommended mineral fertilization doses.

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الملخص العربى

تأثير بعض المخصبات على خفض استخدام الاسمدة المعدنية و النمو الخضرى والحالة الغذائية والمحصول وجودة الثمار لأشجار الرمان

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- تم أستخدام لقاح مكون من مخصبات حيوية هى (بيوجين + نيتروبين + فوسفورين) والتى تحتوى على ميكروبات أزوتوباكتر وازوسبريليوم والباسيلس ميجاثريوم و المضاف اليها ميكوريزا الداخلية وذلك لدراسة تأثيرها على النمو الخضرى والحالة الغذائية والمحصول وجوده الثمار وأيضا بغرض تخفيض الجرعة الموصى بها من الأسمدة المعدنية الأزوتية والفوسفورية والمستخدمة فى تسميد أشجار الرمان العربى عمر 8 سنوات والمنزرعة فى تربة رملية.
- أدى استخدام المخصبات الحيوية الى زيادة معنوية فى طول الفرع ومساحة الو رقة ووزنها الجاف ومحتواها من الكلورفيل الكلى عند المقارنة بالأشجار التى لم تخصب حيويا (الكونترول)
- كما أدى التخصيب الحيوى للأشجار إلى تحسين محتوى الأوراق من الكربوهيدات الكلية وزاد تركيزها من عناصر النتيروجين والفوسفور والكالسيوم والحديد والزنك بصورة معنوية ، وكانت الزيادة غير معنوية لعنصرى الماغنسيوم والحديد.
- كما أوضحت النتائج زيادة معنوية فى محصول الأشجار (وزن وعدد) التى تم تخصيبها حيويا حيث سجلت المعاملتين (تسميد حيوى + 100% من الجرعة الموصى بها من الأسمدة المعدنية) و (تسميد حيوى + 75% من الجرعة الموصى بها من الأسمدة المعدنية) أعلى وزن وعدد ثمار ، وفى نفس الوقت سجلت المعاملة الثانية (تسميد حيوى + 75% من الجرعة الموصى بها من الأسمدة المعدنية) أعلى طول وعرض ومتوسط وزن للثمرة وحسنت معنويا من القياسات الكيماوية لجودة الثمار (أنخفض محتوى العصير من الحموضة وأزدادت نسبة المواد الصلبة الذائبة ومحتوا ه من الأنثوسيانين) أيضا سجلت المعاملة الثانية زيادة غير معنوية لمحتوى العصير من فيتامين ج ونقص لمحتواه من التانينات الكلية.
- بوجه عام يتضح أن المعاملة بالتسميد الحيوى + 75% من الجرعة الموصى بها من الأسمدة المعدنية أعطت أفضل النتائج من حيث الحصول على نمو خضرى جيد وأزدادت الكفاءة التمثيلية للورقة بزيادة محتواها من الكلورفيل وتحسنت الحالة الغذائية للأشجار ، كما أدت إلى زيادة المحصول مع تحسن جوده الثمار ، بالإضافة الى توفير تكلفة استخدام 25% من الأسمدة المعدنية.