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Is it Possible to Compensate the Annual Fertilization in Mandarin Orchards by Using the Bio-fertilizers?

Aiman K.A. Mohamed * [Z] Mohamed M.M. Ahmed **
Mohamed.M. El-Akkad *
* Horticulture Department, Faculty of Agric. Assiut University, Egypt
** Soil, Water, Enviro. Res. Instit. Agric. Research Center, Giza, Egypt
[Z] Corresponding author, e-mail:aimanmohamed@hotmail.com

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Abstract

An experiment was executed at the Horticultural orchard and the laboratory of fruit section, Faculty of Agriculture, Assiut University, Assiut, Egypt during three successive seasons of 2005, 2006 and 2007 on Balady mandarin trees. The study aimed to investigate the effect of biofertilizers, micro nutrients and their different combinations on the yield and fruit quality as well as the nutrients status in the soil and leaves associated with these treatments. Biofertilizers including Phosphorien, Nitrobien and Potassien were applied at a rate of 250g from each type/tree every season or in combination with chelated elements including Fe, Mn, Zn and Cu. Micronutrients were twice sprayed at 60 ppm on mid March and June.

The results revealed that mandarin yield (kg/tree) significantly increased by 21.7%, 13.1 and 19.0% over the control as a result of applying the biofertilizers alone, a combination of the biofertilizers with micronutrient, and micronutrients spraying alone, respectively (as an average of the three seasons). The study also indicated that the early harvesting on mid December was superior respecting the yield in comparison with the late harvest date on mid February. The results also revealed that all the treatments caused a significant increase in the fruit weight. They also mostly had insignificant effect on the fruit chemical properties.

Applying biofertilizers alone or combined with micronutrients, and the micronutrients alone increased N, P and K content in the leaves as compared to the control. The increment percentages were 9.09%, 9.56% and 11.48% for N%, 20.26%, 15.68% and 30.06% for P, and 42.85%, 56.04% and 56.04% for K, in relation to the later treatments, respectively. Also, micronutrients content in the leaves were enhanced due to the biofertilizers and micronutrients foliar application. Data also revealed that, all the nutrient concentrations in the spring leaves surpassed that in the summer leaves.

The calculated yield/feddan (early harvest date) due to using the biofertilizers (about 9 tons/feddan) removed 6.49, 1.72, and 11.95 Kg/fed of N, P and K, respectively. While, the application of the recommended dose of N, P and K removed 5.35, 1.70 and 13.82 Kg/fed of N, P and K, respectively.

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Introduction

Citrus are the most important fruit crops in the world after grapes. In Egypt, citrus are the prevalent fruit crop and its acreage ranked the first fruit crops. According to the FAO Statistics (year 2002), the area devoted for citrus represented 34.46% of fruit crops acreage producing about 2,243,178 tons. However, the exportation from citrus fruits is only about 300,000 tons mainly oranges.

Balady mandarin (***Citrus reticulata*** Blanco) is the most important edible citrus cultivar after Balady orange. It has a good flavor and aroma and it can be exported to the European markets. For commercial exploitation, mandarins have several disorders for instance; the tree has a tendency toward alternate or irregular bearing. Additionally, the mandarin fruit harvested too late on January and February or later loses moisture and become shriveled and unmarketable. Accordingly, the fruit quality of mandarins must be maintained to increase the exportation and net income.

Increasing realization of the ill effects of long sustained, exclusive use of chemical fertilizers, and consistent growing demand from the consumers for fruit quality, coupled with unsustainable productivity of citrus, have fostered experimentation with some alternative cultural practices. Organic culture is claimed to be the most benign alternative. Use of organic materials such as farmyard manure, cakes of plant origin, vermicompost, and microbial bio-fertilizers on one hand, and exploiting the synergism between citrus-vesicular arbuscular mycorrhizal fungus on the other hand, are important components of the bio-organic concept of citrus cultivation, **(Srivastava *et al 2002*).** It is known that the environmental pollution due to excessive use and misuse of chemical fertilizers and pesticides is directly caused problems to the human health. Consequently during the last 2 decades, many of the farmers began to shift towards other alternatives e.g., the biofertilizers. So, the Biofertilizers are able to increase the yield of fruit crops that are important food for people and it can clean the environment and mobilize the productive capacity of land by reducing the amount of chemical fertilizer consumption.

Fertilizers are added to mandarin periodically in order to supply the amounts of nutrients exported from the soil with the harvested fruit and in order to replenish the soil nutrients reservoir. However, there is not much experiment evidence of citrus yield response with natural processes without supplementation by fertilizers.

Biofertilizers are microbial inoculants (preparations containing living micro organisms) which enhance production by improving the nutrient supplies and their crop availability. There are a number of inoculants can serve as useful components of integrated plant nutrient supply systems. Such inoculants may help in increasing crop productivity by increasing biological N fixation, availability or uptake of nutrients through solubilization or increasing absorption, stimulation of plant growth through hormonal action or antibiosis or by decomposition of organic residues **(Subba- Rao, 1984; Subba-Rao, *et al*.; 1993; Wani, and Lee, 1995; Wu *et al* 2005).** Growth, nutritional status of trees, yield and fruit quality of citrus was greatly improved by the application of organic and biofertilizers aside from mineral N forms **(Ahmed, *et al*., 1995; Sharawy, 2005).**

On the other hand, micronutrients deficiency is the most common in areas with alkaline soils However; this deficiency is corrected by foliar sprays. In this respect, Fe, Mn and zn chelate can be applied safely at any time of the growth season at proper rates **(Roger, 2005; Naguib *et al*., 2007).** Moreover, zinc foliar sprays before anthesis may be beneficial in terms of fruit yield in citrus and grapes **(Swietlik, 2002).** The positive effects of zinc sprays on nutritional status, fruit set, fruit retention, reducing fruit drop, yield and fruit quality were supported by many investigators, (**Shawky *et al*. 1990; Ismail 1994; Nahklla 1998; Sayed *et al*. 2004).**

Finally, the quantities of nutrients in harvested fruits are those removed from the tree-soil system on an annual basis **(Alva and Paramasivam, 1998)**

The objectives of this paper were to evaluate the effect of some biofertilizers as a biological technique as an alternative to chemical fertilizers, chelated elements spraying and their combinations on mandarin productivity and quality, nutritional status in mandarin leaves produced from spring and summer growth cycle, soil nutrient contents, and nutrient removal by mandarin fruit. As well as the effect of mandarin harvesting time on productivity and quality was studied.

Materials and Methods

This experiment was conducted at the Horticultural Orchard and the laboratory of fruit section, Faculty of Agriculture, Assiut University during three successive seasons of 2005, 2006 and 2007. The objective of this investigation was to study the response of yield and fruit quality of Balady mandarin to application of biofertilizers and spraying with chelated elements. Sixty trees of Balady mandarin, thirty years old were chosen. The tree spacing was 5 x 5 m apart (168 trees/fed). They were budded on sour orange (*Citrus aurantium var. amara*) rootstock and planted in a clay soil under flood irrigation system. Ten trees of Balady mandarin cultivar for each treatment included the control with uniform growth were selected.

The six treatments involved in this study were summarized as follows:

1- Biofertilizers application (T1).
2-T1+Micronutrient foliar spraying (T2)
3-Micronutrient foliar spraying (T3).
4-Soil application (1/4+1/2+1/2kg ammonium nitrate, super phosphate and potassium sulphate, respectively) + Micronutrient foliar spraying (T4).
5-Soil application (1/4+1/4+1/4kg ammonium nitrate, super phosphate and potassium sulphate, respectively) (T5).
6-Soil application (1/2+1+1/2kg ammonium nitrate, super phosphate and potassium sulphate, respectively) (T6) (control).

The biofertilizers were obtained from the Unit of Biofertilizers, Fac. Agri., Ain Shams University. The commercial names of the applied biofertilizers were Nitrobien, Phosphorien and Potassien. Nitrobien, containing a combination of nitrogen (N)-fixing bacteria *Azotobacter chroococcum* and *Azospirillum liposerum*; Phosphorien containing the phosphorus (P)-solubilizing bacteria *Bacillus megatherium* while Potassien containing *Bacillus circulans.* The biofertilizers were applied at a rate of 250g/tree/season at one dose on the spring season (March). Biofertilizers added in holes around the trunk of the tree and was directly irrigated after covering the holes with soil. Micronutrient foliar spraying included Fe, Mn, Zn and Cu in chelated form at a rate of 60 ppm twice on mid March and June. A surfactant super film at 0.1% was added to the spraying solution. The trees were sprayed using the motor sprayer (600L) until runoff. Ammonium nitrate (33.5% N) , super phosphate (15.5 % P_2O_5) and potassium sulphate (48%K_2O) were used as mineral fertilizers. Phosphorus and potassium were applied on spring (March) season, while nitrogen was applied at three equal batches on the first week of March, May and July.

Composite soil samples represented the whole orchard were taken till 30 cm depth according to **Srivastava and Singh (2002).** Soil analysis was carried out according to **Chapman and Pratt (1961)** and the obtained data are shown in Table 1.

The fruits were harvested on two occasions each one consisted of 5 trees from each treatment in order to study the effect of mandarin harvesting time on productivity and quality. The first harvest date was on mid December and the second one was on mid February every season. Data on total yield (kg/tree) and number of fruits/tree were recorded. Random samples of 10 fruits per replicate (tree) were taken to measure: fruit weight (g) and fruit volume using water displacement. Total soluble solids percentage (TSS %) using the hand refractometer, total acidity (g/100g) using titration by NaOH at 0.1% and phenolphthalein as an indicator and expressed as citric acid along with TSS/acid ratio.

Number of the growth flushes of either spring or summer were marked and then, a number of mature leaves were picked from the labeled shoots from each tree (1st week of Jun and October) according to **Nijjar (1985).** Leaves, washed with tap water then with distilled water, dried at 70˚C until constant weight, ground and finally digested. The digested solution was used to determine N, P, K and micronutrients including Fe, Mn, Zn and Cu., which estimated by standard procedure according to **Wilde *et al* (1985)**. In order to calculate N, P and K removal by mandarin fruits on the both early and late harvest date; samples of fresh fruits from each harvest date was washed, milled and digested. N, P and K fruit removal was estimated by multiplying the nutrient % in the yield. Nutrients removal were calculated as kg/fed and as quantities of nutrients removed by one ton fresh fruits. Composite soil samples were taken for each treatment and after harvesting each yield for the three seasons at depth increments to 30 cm and from four sides of the tree. Soil samples were prepared to the analysis. The macro and micronutrients were determined according to the procedures described by **Black (1965).**

The experiment was set up as a complete randomized design in a split plot model. The whole experiment consisted of sixty trees. Six treatments combinations were tested with ten replications for each treatment and a tree was the experimental unit (replicate). Combined analysis over seasons was used, according to the methods described by Snedecor and Cochran (1980). Means were compared using the least significant differences (LSD) values at 5% levels of the probability.

Table 1**:** Physical and chemical properties of the used soil:

Particle size			PH (1:1 susp.)	E.C (1:1) dS/ m-1	CaCo3 %	Organic matter %	Macro nutrients			Micro nutrients			
Clay	Silt	Sand					Total N%	Av. P (ppm)	Ex. K (ppm)	Fe	Mn	Zn	Cu
49.1	30.9	21.1	7.91	1.11	2.22	2.50	0.11	15.5	322	3.55	1.81	1.43	0.62
Clay													

Results

Yield components and fruit quality

The effect of different fertilization treatments on the yield and fruit quality of Balady mandarin was presented in Tables 2–5. The results presented in Table 2 (first harvest date.) and Table 3 (second harvest date.) showed significant differences among the treatments and the seasons for most of the studied characteristics.

Table 2 reveled that the number of fruits and yield weight (kg) significantly increased as affected by T1 and T3 comparing to the control (T6), while the remained treatments showed insignificant effect. Additionally, the differences between T1, T2 and T3 were not significant. On the other hand, the differences between the seasons of study were significant. Data showed that T1 in the first season recorded the highest yield and fruit number followed by T3 then T2 in the same season while, in the second season, T5 produced the least values followed by the control. All the treatments caused a significant increase in fruit weight. The differences between the first season of study and the second or third season were significant while there were insignificant differences between the second and third season of study. The heaviest fruit was produced from T1 in the second season followed by the same treatment in the third season while, the least value was obtained from the control in the first season and third one. T1 and T3 caused a significant increase of pulp weight compared to the control. The differences were also significant between the second and third season in this respect. T4 in the first season recorded the highest value of pulp weight while the control in the same season gave the lowest value

Table 3 (second harvest date) showed the effect of treatments, seasons and their interaction on such previous traits. The effect of treatments on all traits was not significant (except T1 on pulp weight) compared to the control. Concerning the effect of seasons, it could be observed that the differences were significant between the first season and the other two seasons. T1 in the first season recorded the highest yield weight and fruit number/tree followed by T5 in the first season while the control in the second season gave the lowest values. T4 in the third season gave the highest fruit weight while T1 in the first season recorded the lowest one. The highest value of pulp weight was produced from T4 in the second and third season while the lowest value was produced from T1 in the first season.

Tables 4 and 5 showed the effect of different treatments on the fruit quality at the first and second harvest date. Table 4 (first harvest date) showed that all the treatments (except for T5 on TSS %) had insignificant effect on TSS%, acidity and TSS/acid ratio. The highest value of TSS% was obtained from T4 and T5 in the first season and T5 in the third season. While, the lowest value in this respect was obtained from T1 in the first and third season and the control in the second season. Table 5 revealed that T2, T5 and T6 had a significant effect on TSS% comparing with other treatments while, the treatments showed insignificant effects on the acidity% and TSS/acid ratio. T5 and T2 recorded the highest value of TSS% in the first season while T3 gave the lowest value.

Nutrient concentrations in the mandarin leaves

Average of the nutrient concentration in mandarin leaves as affected by the three growing seasons are presented in Tables 6, 7 and 8. Nitrogen N% and phosphorous P % concentration in mandarin leaves tended insignificantly to decrease in the 2nd season compared to the 1st one. However, N% tended again to increase in the 3rd season. Also, P % concentration in mandarin leaves produced either from summer or spring growth cycle did not affect by the growing seasons, while, N % concentration in mandarin leaves in spring growth cycle significantly affected by growing seasons. Average of potassium (K %) concentration was significantly affected by the three growing seasons. However, K% concentration significantly decreased in the 2nd season and increased again in the 3rd season compared to the 1st season.

Data presented in Tables 9-12 clearly showed that the averages of the micronutrients concentration (Fe, Mn, Zn and Cu) in mandarin leaves were significantly affected by the three growing seasons. Results indicated that average of Fe and Mn significantly and gradually increased in the 2nd and 3rd season compared to the 1st season. This held true either in summer or in spring flushes. However, the average of Zn% concentration significantly decreased in the 2nd and increased again in the 3rd season. Average of Cu% significantly increased in the 3rd season compared to the 1st season. Presented data indicated that all nutrient concentration in the spring leaves greater than that in the summer leaves.

The average of all nutrients in mandarin leaves (Tables 6-12) was significantly affected by the treatments. Data revealed that the average values of N, P and K significantly increased as affected by T1, T2 and T3 comparing to the control, while, the least values were recorded in the control treatment (T6). Data showed significant differences in the average of micro nutrients between the treatments. Data revealed that the high values of Fe, Mn, Zn and Cu were recorded with T2, while, the least values were recorded with the control (T6).

Tables 9-12 showed a significant effect of the interaction between the growing seasons and the treatments on nutrient concentrations in both summer and spring mandarin leaves. N% decreased in the 2nd season in all treatment except in T2 and T6 and significantly increased in the 3rd season. T2, T3 and T4 recorded the highest values of N, P and K in the 3rd season. Moreover, the highest values of Fe, Cu and Zn were recorded with T2 in the 3rd season. While, the highest values of Mn (65.80 ppm) in the 2nd season was recorded with T2. On the other hand, the least values of micro nutrients were recorded with the control treatment either in the 2nd or in the 3rd season.

Nutrient removal by the mandarin fruits:

Data presented in Tables 13 and 14 showed the effect of growing season on N, P and K removed by mandarin fruits. There were significant differences between all growing seasons in N, P and K removed by mandarin fruits. The highest average values of N, P and K (Kg/fed.) removed by mandarin fruits were recoded in the 1st season. While, the minimum values of N, P and K removed by mandarin fruits were recorded in 2nd season.

Nutrient concentrations in the soil

The average of soil nutrient contents as affected by the growing seasons is presented in Tables 15, 16 and 17. Nutrients averages under this study were significantly affected by the growing seasons. Results presented in Tables 15 and 16 clearly showed that total N% and available K (ppm) significantly decreased with the time while, the concentration of available P (ppm) in the soil was significant and gradually increased in the 2nd and 3rd season compared to 1st one. Iron and manganese tended to increase in the 2nd season and decrease again in the 3rd one. Meanwhile, Zn significantly decreased from season to another one.

Regarding the effect of treatments on the soil nutrient contents, data revealed that the highest values of N, P and K were recorded with T6, T1 and T4, respectively. Additionally, the highest values of all micronutrients were recorded with T1 except Zn content which recorded with T2. There were significant effects of the interaction between the growing seasons and the treatments respecting the soil nutrient content. Generally, N content in the soil significantly decreased with the time. The lowest values of the total nitrogen in all treatments were recorded at the end of the 3rd season from the experiment.

On the other hand, the maximum value of soil N content was recoded with T5 in the 2nd season. Available P significantly increased from season to another one under all fertilization treatments. Highly reduction in the available K in the 3rd season was observed in all treatments compared with the 1st one. Available Fe and Mn were increased from the 1st season to the 2nd one, and then they decreased again in the 3rd season. This held true under all treatments. The great value of these nutrients was recorded with T1 in the 2nd season. Zinc and copper gradually decreased from season to another one for all the treatments. The highest value of Zn was recorded with T2 in the 1st season while, the maximum value of available Cu was recoded with T2 in the 3rd season.

Discussion

The present study showed that there was a significant increase in fruit number and yield weight/tree on the first harvest date due to using of the biofertilizers (T1) and chelated elements (T3). The increment percentage in fruit number associated with these two treatments was 21.0 and 19.2, respectively while it was 21.7 and 19.0 in case of yield weight for both treatments, respectively. Combined application of the biofertilizers with spraying by chelated elements caused also an increase in both traits but this increase statistically was not significant. Such increment percentage was 7.1 and 13.1 for fruit number and yield weight, respectively.

Respecting the second harvest date, the treatments led to an increase of fruit number and yield weight but this increase was not significant. The study also revealed that the effect of treatments, seasons and the interaction on the chemical fruit properties, except in TSS%, was not significant..

The results also indicated that TSS% and TSS/acid ratio were increased by delaying the harvest but the obtained values of them on the first harvest date were also attained their maturity standards.

The study showed that the early harvesting caused an increase in the fruit number and yield weight in the following seasons for the same trees comparing with delaying the harvest. The later can be attributed to that the harvesting during December give suitable conditions for flower bud induction where the reports indicated that the flower bud formation occurs during this month. Subsequently, the presence of yield on the trees during this times leading to a decrease of floral initiation.

Nutrient removal by plants is one of the methods used to develop fertility recommendations. This information alone is not adequate for making fertility recommendations because it does not take into account the ability of the soils to retain and supply nutrients. It can, however, indicate the rates at which reserves of soil nutrients will be depleted. The amount of nutrients removed by mandarin fruits was calculated in each treatment in each season in order to give an optimal decision on how much fertilizer can produce a large crop of mandarin. It is important to emphasize that the quantities of nutrients are simply the total amount of nutrients in the fruits. In other words, one feddan of mandarin which produces approximately 9 tons fruits removed 6.49, 1.72, and 11.95 Kg of N, P and K, respectively. These are referred to as the nutrient removal by year and are dependent on the fruit production levels. The removal of nutrients is largely similar across all treatments. However, that of N for a given target fruit yield was much lower was recorded for the control treatment in T6. The nutrient removal in fruits due to the control treatment in T6 was 5.35, 1.70, and 13.82 Kg/feddan of N, P and K, respectively. The nutrient removal in the fruits is an important data for developing crop nutrient budget, particularly for a perennial crop since there is a large carry over of nutrients from year to year from that stored in the tree **(Alva and Paramasivam, 1998).** Also, the quantities of nutrients in harvested fruits are those removed from the tree-soil system on annual basis.

The abovementioned results and discussions can be encouraged by many researches. For instances, In Citrus, **Mansour and Shaaban (2007)** studied the influence of supplying N at 1000g / tree from three sources of mineral N namely ammonium sulphate (21.5% N), ammonium nitrate (33.5 % N) and urea (46.5% N) applied with Compost El-Neel (1.6-2.0% N) and Biogen at various proportions on leaf area, NPK, yield and fruit quality of Washington Navel orange trees. They found that combined application of N through mineral sources at 50 % out of the recommended rate of N plus Compost El- Neel and Biogen each at 25% was effective in improving leaf area, N %, yield and fruit quality compared to using N completely via mineral sources or using mineral N at 25 % with the other organic and biofertilizers. The best sources of mineral N applied with organic and biofertilizers were ammonium sulphate, ammonium nitrate and urea, in descending order. Generally, fertilizing Washington Navel orange trees with N at 1000 g / tree in the form of ammonium sulphate at 2.43 kg/ tree, Compost El- Neel at 11.63 kg/ tree and Biogen at 250 g / tree gave a striking effect on yield and fruit quality. **Sharawy (2005)** found that combined application of N through mineral, compost El-Neel and Biogen to Balady lime was effective in improving leaf area, percentages of N, P, K in the leaves, yield and fruit quality compared to use each source alone. **Attia *et al* (2002)** studied the influence of 3 levels of mineral P and soil inoculation with biofertilizer on the yield, fruit quality and leaf mineral status of mature Balady mandarin trees. They found that mineral P fertilization improved yield, fruit quality and leaf mineral status compared with the unfertilization. Soil inoculation with phosphate solubilizing bacteria significantly increased the yield and fruit quality as well as improved the leaf mineral status as compared with the control. Using mineral and biofertilizer P together was more effective than that of either alone. **Abou Sayed-Ahmed and Abd El-Bary (1997)** studied the effect of soil application of Nitrogen in different forms of mineral or organic to Balady mandarin trees grown in sandy soil. They found that organic manure increased soil water holding capacity, total N, available P and K as well as soil content of different microelements. On the other hand, the combinations between mineral and organic fertilizers caused the highest yield and best fruit quality. **Helail and El-Deeb (1993)** stated that soil inoculation with mycorrhizal fungi enhanced seedling growth and encouraged the development of lateral and roots of Rangpur lime. **Boutros *et al* (1995)** found that mycorrhizal inoculation stimulated vegetative growth of lime trees grown in calcareous soil.

Esitken *et al* (2006) on sweet cherry found that plant growth promoting rhizobacteria stimulated plant growth, significantly increased yield per trunk cross-sectional, fruit weight and shoot length compared with the control. In addition, N, P and K, Fe, Zn and Mn contents of sweet cherry leaves significantly increased as compared with the control. They concluded that Pseudomonas BA-8 and Bacillus OSU-142 alone or in combination have a great potential to increase the yield, growth and nutrition of sweet cherry plant.

It could be concluded that biofertilizers as nitrobien, phosphorien and potassien can secrete growth promoting factor, i.e., gibberellins, cytokinins like substance and auxins which stimulated plant growth and yield, **(Hartmann *et al*. 1983; Saber, 1993; vessey 2003).** Yield and quality of mandarin improved by micro nutrients foliar sprays as reported by **Ibraheim *et al.* (1993) and El - Fangary (1998).**

A few soils contain sufficient nutrients to allow them to be mined for many years without a significant loss of yield, but the majority of soils can only be exploited for a few years before their ability to supply nutrients falls to a low level. If yields are to be maintained, and the soils used to produce crops on a continuing basis, a method by which nitrogen, phosphorus, potassium and other nutrients can be replaced has to be found. The present study indicated that, generally, N%, P% and K% concentration in mandarin leaves were decreased in the 2nd season compared to the 1st season. These results probably due to the assimilation process of N, P and K in mandarin tree in the second season (off year). The increase and decrease in nutrients in the leaves may be due to the mobilization of nutrients from the old leaves to the new one where the old leaves consider the main reserve organs in citrus **(Legaz *et al,* 1995)**.

The optimal concentration range in mandarin leaves for Fe is 60-120 ppm, for Mn and Zn is 25-100 ppm and for Cu is 5 to 20 ppm (**Kao *et al.,* 1984).** As compared to the above optimal ranges, concentration of Fe and Mn in mature summer leaves due to the control for Fe was lowers than that the minimum range. The increment percentage of Fe increased in the 2nd and 3rd seasons by 9.06 and 30.85% compared to the 1st season, respectively. Additionally, the increment percentage of Mn increased in the 2nd and 3rd seasons by 27.42 and 32.05% compared to the 1st season, respectively. The increment percentage in Fe and Mn during the 3rd season in summer and spring leaves recorded 28.88% and 32.3% for Fe and 25.36% and 37.45% for Mn compared to the 1st season, respectively. On the other hand, average of Zn% concentration decreased in the 2nd season by 13.48% as compared to the 1st season. Moreover, maximum average of Zn% and Cu concentration was recorded in the 3rd season.

Generally, all the treatments enhanced N, P and K content in the leaves as compared to the control and the highest values were recorded by T1, T2 and T3 treatments comparing to the control (T6). These increment percentages were 9.09%, 9.56% and 11.48% for N%, 20.26%, 15.68% and 30.06% for P, and 42.85%, 56.04% and 56.04% for K, respectively. These results might be due to the role of microorganisms to deliver a number of benefits including secrete additional enzymes, librating more nutrients until both the humic acid and bacterial population are satisfied and tolerance to adverse soil conditions **(Kaci *et al.,* 2005**). Moreover, the highest values of all micronutrients concentration were recorded with T2 in spring leaves compared to the other treatments either in summer or spring leaves. Spraying micronutrients combined with bio fertilization (T2) increased average concentration by 78.21% for Fe, 34.56% for Mn, 45.66% for Zn and 74.36% for Cu, respectively, as compared to the control, respectively. The significant differences in micronutrients concentration in mandarin leaves could be attributed to the differences between treatments under the present study and to their enhancement of nutrional status. These results are in agreement with those reported by **Alva and Tucker (1992); Ibraheim *et al*. (1993); El-Fangary (1998).**

Data indicated that maximum values of N, P and K were obtained in the 3rd season and differ with type of treatment. The highest values of N were recorded with T2, T3 and T4 in the 3rd season. While, the highest values of P and K were recorded with T3. The minimum values of N, P and K were recorded with the control treatment. N% concentration in mandarin leaves decreased in the 2nd season in all treatment except in T2 and T6 and significantly increased in the 3rd season. Bio fertilizer and micronutrients foliar application in T2 recorded gradually increase in N, P and K concentration in mandarin leaves from season to another one. This increase could be attributed to the continuous stimulation of microorganism through the biofertilizers. Moreover, the highest values of Fe, Zn and Cu were recorded as a result of biofertilizer combined with micronutrients foliar application in T2 in the 3rd season while, the same treatment gave the highest Mn concentration (65.80 ppm) in the 2nd season. These results are in agreement with **legaz *et al* 1995.**

Most cultivated soils in Egypt are clay to loamy in texture. The average results of physical and chemical analyses of soils, sampled at various locations to represent the various types of soils, indicated that the organic matter content is low and so, accordingly, is the concentration of total nitrogen. As regards the alluvial soils (clayey and loamy clay), available phosphorous is generally moderate, available (soluble and exchangeable) potassium extracted with a neutral solution of ammonium acetate is high, and this is characteristic of most Egyptian alluvial soils. Micronutrients are above the critical limits. Levels of available phosphorus, potassium and micronutrients are fairly low on calcareous and sandy soils. (**FAO, 2005*).***

The current study indicated that the total nitrogen and available K decreased by 13.82% and 8.33% at the end of the 3rd season compared to the 1st one, respectively. Average of available P increased in the 2nd and in the 3rd season by 17.01% and 32.63% compared to the 1st one, respectively. Micronutrients content in the soil significantly increased in the 2nd season, and then decreased again. Data revealed that the highly decrease in total N% in the 3rd season compared to the 1st one in T1 and T2 due to the use of biofertilizers (Nitrobien, Phosphorien and Potassien at a rate of 250 g/tree/year) and biofertilizers plus foliar spray, respectively, could be attributed to the improvement of soil condition which led to an increase of the mandarin productivity and consequently increased N uptake. The maximum values of N (0.130%), P (22 ppm) and K (363 ppm) were recoded with T6, T1 and T4, respectively while; T1 recorded the highest values of Fe (4 ppm), Mn (1.74 ppm) and Cu (0.52 ppm). It was observed significant differences in soil nutrients content between the treatments in each growing season. Minimum value of total N recorded with the control in the 3rd season. Highly reduction in available P and exchangeable K in the 3 rd season in all treatments compared with the 1st one. Meanwhile, maximum values recorded either to the biofertilizer effect on P availability in the 3rd season in T1, or to the soil application of the half dose of the recommended dose of N, P and K on available K in T4, The maximum micronutrients values ranged between T1 for Fe (4.8 ppm) and T4 for Mn (2.21 ppm) in the 2nd season, or T2 in the 1st season for Zn (1.98 ppm) and T4 in the 3rd season for Cu (0.56 ppm). Application of biofertilizer only (T1) or in combination with micronutrient foliar spray (T2) or N, P and K soil application are the main source of this increase. The flocculation in P and micronutrients in the soil could be explained according to flocculation in soil pH which affected by microorganisms through the production of organic acids and lowering soil pH **(Saber, 1993).** Such biofertilizer may help in increasing crop productivity by increasing biological N fixation (BNE), availability or uptake of nutrients through solubilization or increasing absorption, stimulation of plant growth through hormonal action or antibiosis or by decomposition of organic residues **(Wani and Lee. 1995).** Same effect was reported by **Mansour and Shaaban (2007)** by application of Biogen as a bio fertilizer on Washington Navel orange trees.

Conclusion: It could be concluded that the biofertilizers; nitrobien, phosphorien and potassien increased mandarin yield and improved fruit quality by enhancing the nutrient soil content, nutrient status in mandarin leaves especially in the spring growth cycle and N, P , K removal by the mandarin fruits. Accordingly, it is possible to refrain from fertilizing the mandarin orchards planted in the heavy soils for several years and can compensate it by using the biofertilizers. Finally, it can be recommended that using the biofertilizers and harvest mandarin yield from the trees during December for obtaining a better yield with reasonable fruit quality.

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هل يمكن استبدال التسميد السنوي فى بساتين اليوسفي باستخدام الأسمدة الحيوية ؟

*أيمن كمال أحمد محمد **محمد محمود أحمد *محمد مجدي العقاد
* قسم البساتين – كلية الزراعة – جامعة أسيوط
** مركز بحوث الأراضي والمياه والبيئة- مركز البحوث الزراعية- الجيزة – مصر

أجريت الدراسة لمده ثلاث مواسم زراعيه متعاقبة (2007/2006/2005) على أشجار اليوسفى البلدى عمرها 30 سنه مطعومه على أصل نارنج ومزروعة في تربه طينيه بمزرعه قسم الفاكهة - جامعه اسيوط – جمهورية مصر العربية.
اضيفت الاسمده الحيويه المحتويه على النيتروبين و الفوسفورين بالاضافه الى البوتاسين بمعدل 250 جرام/شجره/سنه و كانت الاضافه للاسمده الحيويه اما معا - او بالاضافة الي الرش بالعناصر المخلبيه المحتويه على الحديد المنجنيز الزنك و النحاس - و التى تم رشها مرتين خلال الموسم بتركيز 60 جزء/مليون و كانت النتائج كالتالى :
1- حدثت زيادة في متوسط وزن المحصول للشجره الواحده خلال المواسم الثلاثه بمقدار 21.7% و 13.1% و 19% مقارنه بالكنترول (الاسمده الموصى بها) نتيجه أضافه الاسمده الحيويه معا - او الاسمده الحيويه و الرش بالعناصر المخلبيه - او الرش بالعناصر المخلبيه فقط على التوالى .
2- كان الحصاد المبكر خلال شهر ديسمبر اكثر تاثيرا على المحصول و مكوناته مقارنه بالحصاد المتاخر فى شهر فبراير .
3- احتوت الأوراق الناتجة من دورة النمو الربيعي على تركيز أعلى من العناصر الغذائيه مقارنة بالأوراق الناتجة من دورة النمو الصيفي.
4- أعطت معامله إضافه الأسمده الحيويه بمفردها أو مع الرش بالعناصر الصغرى او الرش بالعناصر المخلبيه المحتويه على الحديد المنجنيز الزنك و النحاس بمفردها زياده محتوى الاوراق من النتيروجين بمقدار 9.09 و 9.56 و 11.48 % و للفسفور بزياده قدرها 20.26 و 15.68 و 56.4% و للبوتاسيوم بزياده قدرها 42.85 و 56.04 و 56.04% مقارنه بالكنترول على التوالى – كما ادت معامله التمسيد الحيوى مع الرش بالعناصر الصغرى الى زياده تركيز العناصر الصغرى .
5- كان إنتاج الشجرة الواحدة من اليوسفى المضاف لها المخصبات الحيوية هو 53.9 كجم/للشجرة (كمتوسط ثلاثة مواسم) أي حوالي 9 طن ثمار للفدان وأدى هذا المحصول (9 طن) إلى استنزاف 6.49 كجم من النتيروجين و 1.72 كجم من الفسفور و 11.9 كجم بوتاسيوم بينما اعطت معامله الكنترول (الاسمده الموصى بها) استنزافا لعناصر النتيروجين و الفوسفور و البوتاسيوم بمقدار 5.35 و 1.7 و 13.82 كجم للفدان والتى يجب أن تؤخذ فى الاعتبار عند وضع البرامج السماديه لاشجار اليوسفى تحت هذه الظروف.