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Effect of Biostimulants, Ethrel, Boron and Potassium Nutrient on Fruit Quality of "Costata" Persimmon

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Abstract: This study was carried out during the two seasons 2006, 2007 on persimmon trees Costata cv., the trees were 16 years old growing in loamy soil at Horticulture experiment station, Kalubeya Egypt, to study the effect of the biostumlants (EM) at 5% as soil or foliar application, boric acid 200 ppm , KNO_3 2 % and ethrel (500,1000 ppm) on yield, some physical and chemical characters of fruits.The trees received EM as soil application showed the highest tree yield (about 33.5 kg. /tree), also was significantly increased fruit weights about (27%, 45%) comparing with control during the two seasons respectively, also foliar application caused about (40%, 23%) increased .The increment in mean fruit weight reached about (36%, 30%) due to potassium nitrate application. Boric acid application achieved about (11%) increase in fruit weight during the two seasons, while spraying with ethrel was not significantly affected fruit weight. Fruit dimensions followed somewhat similar pattern to that of the fruit weight. At harvest, fruit firmness was not much affected by tested treatments except for the potassium nitrate one which significantly increased fruit firmness. Ethrel treatments decreased the fruit firmness and fruits from trees sprayed with the 500 and 1000 ppm were harvested at about the third week of September in the two seasons whereas fruits from control trees were at about the second week of October and the 1000 ppm was earlier five days than 500 ppm. Fruit of the experimental trees showed significant lower acid values, EM soil application gave the lowest fruit acid content (26 %, 27%) in the two seasons. The soluble solid content to acidity ratio was conveyable trend with fruit content from soluble solid content and acidity which the all treatments were increased in the soluble solid content to acidity ratio comparing by control, the highest ratio was Soil application EM 61% in the two seasons. All the treatments were significant decreased in tannins fruit content except ethrel spray in the second season and the lowest tannins content was soil application with EM The conclusion was the EM soil or foliar application with concentration (5%) lead to increasing the yield and improving the physical and chemical properties fruit persimmon Costata cv. Under experimental conditions.

Key words: Persimmon, Kaki, Costata, EM, KNO_3, Boric acid, Ethrel

INTRODUCTION

Persimmon (Diospyros Kaki L.) is a deciduous tree and grows well with good productivity in temperate and subtropical regions. Improving crop yield and fruit quality without adversely affecting the environment, a major good of horticulturist, could be achieved by increasing dependence on bio stimulants in crop production. Bio stimulants were defined by (Russo and Berlyn 1990) as being "non fertilizer which benefits plant growth ".

They may contain micro organism or natural products such as cytokinins, amino acids and Humic acids.

Biostimulant products are laid to increase plant's nutrient and water uptake (Russo and Berlyn 1990, Schmidt, 1990). Soil microbiologists and microbial ecologists have tended to differentiate soil microorganisms as beneficial or harmful according to their functions and how they affect soil quality, plant growth and yield, and plant health. A more specific classification of beneficial microorganisms has been suggested by Higa (1991 and 1995), which he refers to as Effective Microorganisms or EM. If used properly, EM can significantly enhance the growth, yield and quality of crops (Higa and Wididana,1991), (Abd-El-Messeih 2005).

Application of EM to mung bean (*Vigna radiate*) field soil improved nutrient uptake efficiencies, enhanced root growth and branching, and increased yield (Sangakkara, 1999).

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EM plus molasses increased onion yield by 29%, the production of highest grade onions by 76 % pea yields by 31 % and sweet corn cob weights by 23% (Daly and Stewart, 1999). Two rice cultivars treated with EM at planting exhibited more vigour growth and no leaf yellowing at high temperature as compared with the control (Nguyen, *et al*., 1999).

EM, effect on fruit quality characters, viz; firmness, TSS content and titratable acidity for at least 10 days in room storage and 40 days in cold storage for Kelsey plum fruit remained in a marketable condition for 60 days at 0 ± 0.5˚ C as compared with only 3:5 days at 20- 26˚ C (Eissa, 2003)

Nijjar 1985 appeared that boron was responsible for building and moving carbohydrates from leaves to fruits and encourages the biosynthesis of cellulose which positively strengthens the cell wall; also Gobara 1999 found that boron application on pear was very effective in reducing the percentage of preharvest fruit drop.

Adequate boron nutrition is critical not only for obtaining higher yields but also for fruit quality. Boron deficiency causes many anatomical, physiological and biochemical changes (Singh, *et al*., 2003).

Several studies pointed out that spraying some deciduous trees with K and Ca at different concentrations either alone or in combination has been used successfully could help in decreasing both fruit weight loss and decay percentage. In addition to, fruits from trees sprayed with K or /and Ca were firmer and better quality than the control fruit during the storage duration (Robertson, *et al*., 1990).

Ethylene is a small hydrocarbon gas. It is naturally occurring, but it can also occur as a result of combustion and other processes. It is thought of as the aging hormone in plants. Ethylene is responsible for the changes in texture, softening, color, and other processes involved in ripening, Ethylene gas is used commercially to ripen tomatoes, bananas, pears, and a few other fruits postharvest. Several commercial liquid products release ethylene (ethephon, trade name Ethrel). These are only used preharvest (Sylvia Blankenship 2000).

This experiment was carried out to study the effect of soil and foliar applied of EM and foliar applied Ethephone (Ethrel), KNO_3, Boric acid on yield, physical and chemical characters of kaki fruit in two successive seasons in 2006 and 2007

MATERIALS AND METHODS

This study was conducted on kaki cv. "Costata" during 2006 and 2007 seasons at Horticulture experiment station, Kalubeya, Egypt. Twenty one trees in sixteen years old persimmon of Coststa cultivar which budded on "Trablos" rootstock and planted at 5 x 5 m. in loamy clay soil were selected for this study. The trees were received the same cultural practices that are recommended.
Complete randomized design was applied.Seven treatments were applied in three replicates.

Code numbers	Treatments
1	Control (water spray only)
2	Soil application of EM
3	Foliar application of EM
4	Foliar application of 200 ppm. Boric acid
5	Foliar application of 2 % KNO_3
6	Foliar application of 500 ppm. Ethrel
7	Foliar application of 1000 ppm. Ethrel

EM is a commercial biostimulant produced by EMRO Corporation, Okinawa, Japan; marketed locally by Ministry of Agriculture and Land Reclamation, Egypt; and contains more than 60 selected strains of "Effective Microorganism", viz, photosynthetic bacteria, lactic acid bacteria, yeasts, actinomycetes and various fungi.

EM suspension used in both soil and foliar applications were prepared one week before to treatment by adding five liters EM and five liters of molasses to 90 liters of water, stirring and leaving the mixture to ferment at ambient temperature until use. Fifteen liters per feddan of this suspension was added weekly into soil around each tree away from tree trunk. Weekly application began on February until harvest on October in the two seasons.

The same preparation was used in foliar EM treatment; each tree was sprayed weekly with 5% of the EM preparation until run off the solution from the leaves, started after leaf emergence in the first of April and continued to the end of the season on October. EM-Bokashi (solid EM) was added on October 3 kg/tree around the trees of EM soil and foliar applications.

EM-Bokashi (useful microbes promoter) was prepared as followed

1- Mix 50 kg of rice bran and 50 kg of olive cake
2- Dissolved 1 liter of Molasses and 1 liter of EM in 100 liters well water (well water preferred since tap water is chlorinated)
3- Pour the EM dilution onto the organic matter (one m^3) gradually and mixed well while checking the moisture content, there should be no drainage of excess water. The moisture content should be about 30-40% and can be checked by squeezing a handful.
4- Put the mixture on the floor and recover it well by plastic sheet to maintain an aerobic condition.
5- Put the mix in a warm location to hasten fermentation for one week
6- EM-Bokashi is ready for use when it gives a sweet fermented smell.

Boric acid was sprayed at the end of the bud burst to the end of March with 200 ppm. KNO_3 was sprayed with 2% when the diameter of fruit at 2-3 cm on the first of July each two weeks until the harvest on October. Ethrel (ethyphone) treatment was sprayed on fruit before premature stage with 500 and 1000 ppm each two weeks until the harvest on mid of September.

Data were recorded on yield, physical and chemical fruit characteristics

Fruit physical characteristics:

In both seasons samples of 10 random mature fruits per tree were used for the determination of average fruit size (volume), weight, height (length), diameter and firmness (Ib/$inch^2$) was measured by using pressure tester (Effegi) with 5/16 inch plunger.

Fruit chemical characteristics:

- Soluble Solids Content (SSC %): Handy refractometer was used to determine the TSS % in fruit juice according to A.O.A.C. (1985).
- Titratable total acidity (%): Fruit juice total acidity % as Malic acid (mgs/100 gms fruit juice) according to Vogel (1968) and A.O.A.C (1985).
- Total tannins (%): Fruit juice total tannins percentage was determined and estimated using the methods described by Winton and Winton (1958).

Data Analysis:

All the obtained data during the two seasons of the study was statistically analyzed of variance method, differences between means were compared using Duncan's multiple range test at 0.05 level according (Duncan, 1955).

RESULTS AND DISCUSSION

Yield and Fruit Quality:

1. Yield:

From data in table (1) it is clear that, both EM, potassium nitrate and boric acid application significantly increased tree yield as kg. /tree comparing with that of the control or ethrel application treatments.

Trees received EM as soil application showed the highest tree yield (about 33.5 kg. /tree) followed by in decreasing order with that of the (KNO_3) at 2% 31.5 kg., EM as foliar application (28.2 kg. /tree) then that of the boric acid at 200 ppm 24.6 kg. /tree while a slight reduction in tree production was noticed for the trees sprayed with ethrel at the two tested concentrations. The same pattern was noticed in the 2007 season.

Ethrel application decreased fruit firmness and fruit from trees received the 500 and 1000 ppm were harvested at about the third of September while the control were harvested about at the second week of October and the 1000 ppm was earlier five days than 500 ppm.

2. Fruit Properties:

2.1. Physical Fruit Properties:

Data in table (1) showed that trees received the EM as soil application yielded the heavier fruit (104.2 gm) whereas fruits of the trees sprayed with KNO_3 at 2% weighted (111.5 gm) followed in decreasing order with that of the EM foliar application (115.3gm) , boric acid (91.2gm) compared with (82.1 gm) for control.

Table 1: Effect of EM, boron, potassium and ethrel on some physical fruit properties (2006-2007)

Treatments	yield (kg./ tree)		Fruit weight(g)		Fruit volume (ml)		Fruit height (cm)	diam.(cm)	Fruit	(lb/inch^2)	Firmness	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Control	20.5 D	22.0 D	82.1 C	90.9 DE	85.2 C	90.3 CD	5.3 DE	5.5 C	5.4 C	5.1 B	15.8 D	14.0 B
EM (soil)	33.5 A	35.8 A	104.2 B	131.6 A	130.6 A	140.2 A	6.5 A	6.7 A	6.8 A	6.2 A	14.8 CD	13.2 BCD
EM (foliar)	28.2 B	32.1 B	115.3A	111.5 BC	118.0 AB	120.2 B	6.0 BC	6.0 B	6.4 AB	6.0 A	15.3 BC	13.7 BC
Boric acid 200 ppm. (foliar)	24.6 C	27.5 C	91.2 C	101.9 CD	95.7 C	105.3 BC	5.6 CD	5.7 BC	5.7 C	5.3 B	14.7 CD	13.2 BCD
KNO_3 2 % (foliar)	31.5 A	34.2 AB	111.5 AB	118.3 B	111.8 B	110.5 B	6.1 AB	6.5 A	6.2 B	5.9 A	16.8 A	15.2 A
Ethrel 500 ppm. (foliar)	19.3 D	20.8 D	81.3 C	89.2 DE	88.5 C	86.4 D	5.3 DE	5.6 BC	5.3 C	5.1 B	14.3 DE	12.2 CD
Ethrel 1000 ppm. (foliar)	18.5 D	19.8 D	83.0 C	87.9 E	83.6 C	92.2 CD	5.1 E	5.4 C	5.5 C	5.0 B	13.5 E	12.1 D

Means in the same column for each treatment followed by the same letter are not significantly different at 5% level according to Duncan`s multiple range test.

In the second season fruit weight was 131.6, 118.3, 111.5, 101.9 and 90.87 for the EM soil application, KNO_3, EM foliar, boric acid spraying and the control respectively. Trees received ethrel treatments showed somewhat similar fruit weight to that of the control in the two seasons

The average fruit volume seems to be connected with the fruit weight, in most cases the higher the fruit weight the higher the fruit volume.

With regard to fruit height trees received the EM as soil application recorded the highest fruit value (6.5,6.7 cm) in the two seasons respectively whereas fruit from trees sprayed with ethrel at the high concentration recorded the lowest value (5.1 and 5.4cm). Somewhat similar results were recorded as fruit diameter was concerned. Here again the EM soil application showed the highest value whereas the ethrel treatments gave the lowest one. As expect fruits from the trees sprayed with ethrel exhibited the lowest fruit firmness value which was significantly lower than that of the control, also the higher ethrel concentration showed the lowest value. Trees sprayed with KNO_3 showed the higher fruit firmness value (16.8 and 15.2) in the two seasons respectively; also fruit firmness trees received EM as foliar application achieved significant higher fruit firmness.

2.2 Fruit Chemical Properties:

Data in (Table 2) cleared that in the first season The soluble solid content of fruit was the highest with EM soil application followed by the KNO_3 whereas the lowest value was fruit control, also in the second season the highest value of SSC was EM soil application, then KNO_3 and EM foliar application were insignificancy while the lowest value was fruit control which insignificant with ethrel 500 ppm.

The fruit of the experimental trees showed significant lower acid values, EM soil application gave the lowest fruit acid content (26 %, 27%) in the two seasons.

The soluble solid content to acidity ratio was conveyable trend with fruit content from soluble solid content and acidity which the all treatments were increased in the soluble solid content to acidity ratio comparing by control, the highest ratio was soil application EM 61% in the two seasons.

All the treatments were significant decreased in tannins fruit content except ethrel spray in the second season and the lowest tannins content was soil application with EM and the highest tannins content was control,

Data referred to EM soil application was given increment in the yield, the largest fruit size, weight and diameter then EM foliar. Firmness of fruit was relatively higher with KNO_3 than EM. (Table 1).

Also EM soil application was the highest in soluble soil content and the lowest in acidity and tannins (Table 2).

So it can conclude that EM soil application was the best treatments for fruit quality

Table 2: Effect of EM, boron, potassium and ethrel on some chemical fruit properties (2006-2007)

Treatments	SSC (Brix)		Titratable acidity (%)		SSC/acidity ratio		Tannins	
	2006	2007	2006	2007	2006	2007	2006	2007
Control	18.0 E	17.0 D	0.54 A	0.48 A	33.43 C	35.57 C	0.82 A	0.73 A
EM (soil)	21.2 A	19.8 A	0.40 C	0.35 C	53.83 A	57.43 A	0.45 F	0.46 D
EM (foliar)	19.6 BC	18.5 BC	0.45 BC	0.40 BC	43.73 B	46.77 B	0.55 E	0.53 CD
Boric acid 200 ppm. (foliar)	18.7 CDE	17.5 D	0.46 ABC	0.40 BC	41.83 BC	44.00 BC	0.68 C	0.64 B
KNO_3 2 % (foliar)	20.2 B	19.0 AB	0.48 AB	0.41 ABC	43.57 B	46.70 B	0.62 D	0.60 BC
Ethrel 500 ppm. (foliar)	18.6 DE	17.5 D	0.47 ABC	0.40 BC	39.73 BC	44.27 BC	0.75 B	0.66 AB
Ethrel 1000 ppm. (foliar)	19.2 CD	17.8 CD	0.43 BC	0.46 AB	44.87 B	38.83 BC	0.70 BC	0.62 B

Means in the same column for each treatment followed by the same letter are not significantly different at 5% level according to Duncan`s multiple range test.

This data was corresponding with the result of soil EM application which resulted in significantly the largest number of fruits set/ shoot and harvested fruit /tree, highest and largest fruit size (weight, size, and polar and equatorial diameters) ,greatest fruit flesh thickness , TSS content and least fruit firmness and titratable acid values. (Eissa, 2003)

Also, the application of ethrel 300 ppm on apple greatly increased the colour of the fruit also tended to show the marked increase in the contents of TSS and sugars but lowered the acidity of the fruit (Singh, *et al*., 2002) On the other hand (Mokhtar and wally 1998) reported that sprayed ethrel at 1000 ppm on persimmon costata cv. accelerated vegetative and flower bud brust ,flower bud development and picking date as compared with control, total tannins content and total acidity were not affected by spraying ethrel.

EM effect on vegetative growth, yield and fruit quality of Kelsey plum found that soil applied EM was significantly the highest count of all groups of microorganism (total bacterial count, total actinomycetes and total fungi) in the rhizosphere soil, in addition significantly increase in NPK content in the soil, also found soil applied EM was higher than foliar applied (Eissa, 2003).

Soil application of K-humate and active bread yeast to apricot trees have been found to significantly increase rhizosphere count of various groups of microorganisms (Eissa, 2002). It also known that yeasts which were provided in the soil EM treatment, produced B vitamins (Barnett *et al*., 1999).

Abd EL-Messeih et al 2005 reported that the EM treatments of Le Conte pear trees had significantly increased the vegetative growth, the number of current shoots/main branch, shoot length and diameter and leaf area. As well as leaf chlorophyll reading and leaf mineral values, N, P, K, Fe, Zn and Mn as compared the untreated trees. The yield and fruit quality i.e. fruit weight, their dimensions, total sugars% and TSS% at harvest were improved as compared to the control. In addition, the fruit quality at the end of marketing period showed an increase in TSS% and total sugars% and a decreased acidity% while fruit firmness was slightly reduced as a result of using EM treatments. The results has also indicated that all the EM applications increased the number of the soil micro flora(total fungi, total bacteria and total actinomycetes and some macro and micro elements i.e. (N, P, K, Fe, Zn, and Mn) in soil as compared to control

Alaa El-Din and Belal 2007 found that the application of organic and bio-fertilizer (*Azotobacter chroococumm* strainEB2) gave the highest concerning yield values and most physical characteristics of mango fruits such as fruit weight, fruit firmness and peel thickness as compared with the other treatments and control also improved chemical characters and gave the highest values among all treatments for total sugars, TSS, vitamin C and lowest value in total acidity.

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