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The Beneficial of Using Citric Acid with Some Nutrients for Improving Productivity of LE- Conte Pear Trees

[1]Mansour, A.E.M., [2]Ahmed, F.F., [1]Shaaban, E.A. and [1]Amera, A. Fouad.

[1]Pomology Res. Dept., National Res. Center, Dokki, Egypt.
[2]Hort. Dept. Fac. Agric. Minia Univ. Egypt.

Abstract: Leaf area, nutritional status of trees, yield and fruit quality of Le- Conte pear trees in response to spraying NPK Zn Fe Mn either singly or in combinations with S, B or citric acid was investigated during 2006 and 2007 seasons. Results showed that single or combined application of these nutrients and citric acid was very effective in stimulating the leaf area, NPK % , yield as well as physical and chemical characters of the fruits rather than the control treatment. The beneficial of NPK Zn Fe Mn application was doubled when S, B and citric acid were applied with NPK Zn Fe Mn, in ascending order. A promising influence was detected on yield and fruit quality when all nutrients and citric acid were appied together. Combined spray of N P K Zn Fe Mn S B and citric acid four times was favourable in improving both yield and fruit quality of Le- Conte pear trees.

Key words: Citric acid, nutrients and pear trees

INTRODUCTION

Le- Conte pear cv is one of the important deciduous fruits grown in Egypt. It suffers from several factors which have a negative effect on its yield. Among these factors the depression of pear yield which may attribute to malnutrition especially with boron, sulphur as well as NPK Zn Fe and Mn . Therefore, amending the trees with their requirements from all essential nutrients at balanced rate is beneficial to overcome the yield reduction.

Any trials aims to enhance production and fruit quality of Le- Conte pear trees are appreciated. Recently using citric acid as antioxidant is suggested mainly for improving yield and fruit quality instead of using synthestic auxins which greatly damaged and polluted out environment. It has many functions in plant metabolism. It catches all free radical produced during plant metabolism, since leaving these free radicals leads to oxidation of lipids, loss of plasma membrane permeability and later the death of the cells and also it has an auxinic action[1].

Boron has beneficial effects on fruit crops especially stone fruits. It has many functions in germination of pollen grains, metabolism of N, P and k biosynthesis and translocation of carbohydrates, movement of natural hormones namely GA_3, IAA, ethylene, cytokinins and ABA and stimulation of cell division[2,3] . It has beneficial effect on controlling different disorders in fruit orchards[4]. These effects of B reflected on enhancing flowering, fruit setting, yield and fruit quality.

Sulphur is considered an essential nutrient responsible for enhancing the biosynthesis of organic foods and cell division. Other nutrients have the same functions in addition to their positive action on plant metabolism and the formation of vegetative and flowering aspects.

Antioxidants were found by many authors to improve growth , yield and fruit quality of stone fruits[5,13].

Previous studies emphasized the promoting effect of B on growth and fruiting of stone fruits[14-19].
The favourable effects of nutrients on growth , yield and fruit quality of stone fruits were supported by the results of Yogaratnam and Greenham[20] ; Cahoon and Donoho[21]; Sud and Bhutani[22]; Mohamed and Ahmed[23]; Mohamed[24], Ahmed *et al.,*[25] Guo and Xu[26] and Ahmed and Morsy[27].

The present study was therefore undertaken to find out the effect of using citric acid along with some nutrients on growth, nutritional status of the trees, yield and fruit quality of Le- Conte pear trees.

MATERIALS AND METHODS

The present study was conducted during 2006 and 2007 seasons on uniform in vigour twenty seven 20 - years old Le- Conte pear trees (*Pyrus Communis* X *Pyrus Pyrifolia*). The trees were budded on Pyrus communis rootstock and grown on clay soil in a private orchard located at El- Fashn district at 4x4 meters apart. The trees received the same horticultural practices that are recommended by The Egyptian

Corresponding Author: Mansour, A.E.M., Pomology Res. Dept., National Res. Center, Dokki, Egypt.

Ministry of Agriculture. Complete randomized block design was adopted. The experiment involved the following nine treatments:

- Control (untreaed trees)
- Spraying NPK Zn Fe Mn
- Spraying NPK Zn Fe Mn + sulphur
- Spraying NPK Zn Fe Mn + boron
- Spraying NPK Zn Fe Mn + citric acid at 0.1 %
- Spraying NPK Zn Fe Mn + sulphur + boron
- Spraying NPK Zn Fe Mn + sulphur + citric acid
- Spraying NPK Zn Fe Mn + boron + citric acid
- Spraying NPK Zn Fe Mn + sulphur + boron + citric acid

Each treatment was replicated three times. Control trees were sprayed with water containing 0.1 % Triton B. Spraying of NPK Zn Fe, Mn, B and S were carried out in the sources of urea at 0.2%, orthorphosphoric acid at 0.1 %, potassium sulphate at 1.0 %, chelated Zn at 0.05 %, chelated Fe at 0.05 %, chelated Mn at 0.05 %, boric acid at 0.05 % and elemental suphur at 0.2 %, respectively (the recommended concentration according to Nijjar,[3]; Ahmed *et al.,*[28] and Gobara *et al.,*[29]. Triton B as a wetting agent was added at 0.1 % for all nutrients and citric acid solutions. Spraying was carried out four times during the two growing seasons. The first spray was carried out at the growth start and the other three sprays were done at first bloom, just after fruit setting and at 30 days later. All trees were sprayed till runoff (10 L/ tree) .

The results of the orchard soil analysis according to Wilde *et al.,*[30] are shown in Table (1):

Samples of twenty leaves from the middle part of the shoots according to Nijjar,[3] were selected at random from each replicate (1st week of July to measure their areas (cm^2) according to Ahmed and Morsy,[9] and to determine their content of N, P and K according to Wilde *et al.,*[30]. Determinations were carried out on a dry weight basis.

The yield as weight (kg.) of each replicate was recorded at harvest time (second week of July).

Samples consisting of fifteen fruits were randomly taken at harvest time from each replicate for determining fruit weight (g.), fruit firmness by Magnes Taylor type pressure tester (Ib/ $inch^2$) , total soluble solids % , total reducing and non reducing sugars % and total acidity (expressed as g malic acid / 100 g pulp According to A.O.A.C.,[31].

All obtained data were statistically analyzed according to Mead *et al.,*[32]. Means were compared using new L.S.D. at 5% level.

Table 1: Soil analysis of the tested soil

Clay %	:52 %
Silt %	: 29.0
Sand %	: 19.0
Texture grade	: clay
E.C . (ds/m^{-1})(1 : 2.5 extract)	: 0.52
pH (1: 2.5 extract)	: 8.1
O.M. %	1.46
Total N %	: 0.29
Available P (ppm, Olsen)	: 4.6
Available K (ppm, ammonium acetate)	: 4.00

RESULTS AND DISCUSSION

Effect of Spraying Nutrients and Citric Acid on the Leaf Area: It is worthy to mention that foliar application of NPK Zn Fe Mn either singly or in combinations with S, B or citric acid significantly was responsible for stimulating the leaf area of Le- Conte pear trees compared with the control. Combined application of S, B or citric acid with NPK Zn Mn Fe was preferable than using NPK Zn Fe Mn alone in this respect. The stimulation on the leaf area was associated with using citric acid, boron and sulphur, in descending order with NPk Zn Fe Mn . Application of citric acid effectively enhanced the improving effect of NPK Zn Fe Mn on the leaf area. Significant differences on the leaf area were observed among the nine treatments. Untreating the trees with these nutrients and citric acid gave the minimum values (27.0 and 28.3 cm^2) in both seasons. The maximum values (50.5 and 47.9 cm^2) of leaf area were recorded on the trees received four sprays of NPK Zn Fe Mn B S plus citric acid. These results were true in 2005 and 2006 seasons.

The promoting effect of NPK Zn Fe and Mn on the leaf area might be attributed to their important role in encouraging photosynthesis and chlorophyll formation as well as producing more carbohydrates and amino acids which aid in the formation of new cells. The stimulation effect of B and S on cell division as well as the acceleration on the formation of organic foods and the movement of IAA could explain the present results[3].

These results are in agreement with those obtained by Ahmed *et al.,*[28], who works on different nutrients and Ahmed *et al.,*[19] who worked on B.

The beneficial effect of citric acid on enhancing the biosynthesis of organic foods as well as its action as natural auxins could explain the present results[1]. These results are in agreement with those obtained by Ahmed *et al.,*[11] .

Effect of Spraying Some Nutrients and Citric Acid on NPK: It is clear from the obtained data in Table (2) that spraying all nutrients with or without citric acid was significantly very effective in enhancing percentages of N, P and K in the leaves compared with the check treatments. Spraying S, B or citric acid along with NPK Zn Fe Mn significantly improved these nutrients in the leaves rather than application of NPK Zn Fe Mn alone. Combined application of NPK Zn Fe Mn and citric acid was superior than the application of NPK Zn Fe Mn with B or S. Combined application (double, triple or four applications) was favourable in enhancing these nutrients than application of NPK Zn Fe Mn alone. Supplying the trees with

Table 2: Effect of Citric acid with some Nutrients on leaf area (cm^2) and its content of N, P and K, yield (Kg) per tree and fruit weight (g) of Le-Conte pear trees during 2005 and 2006 seasons.

Treatment	Leaf area (cm2)		Leaf N%		Leaf P%	
	2005	2006	2005	2006	2005	2006
Control	27	28.3	1.22	1.26	0.11	0.1
NPK Zn Fe Mn	30	31	1.3	1.32	0.14	0.11
NPK Zn Fe Mn + S	32.3	33.4	1.37	1.38	0.16	0.11
NPK Zn Fe Mn + B	35	36	1.42	1.44	0.19	0.14
NPK Zn Fe Mn + Citric acid	38.3	38.1	1.5	1.51	0.22	0.17
NPK Zn Fe Mn + S + B	41.2	40.3	1.55	1.57	0.23	0.19
NPK Zn Fe Mn + S + Citric acid	44.1	43	1.62	1.66	0.26	0.22
NPK Zn Fe Mn + B + Citric acid	48	45.3	1.67	1.71	0.29	0.26
NPK Zn Fe Mn + + S + B + Citric acid	50.5	47.9	1.72	1.8	0.32	0.29
New L.S.D. at 5%	1.9	2	0.04	0.04	0.02	0
	Leaf K% (g)		Yield / tree (kg)		Fruit weight(g)	
Control	0.95	0.91	20	23	125	123
NPK Zn Fe Mn	1	0.95	23	25.5	135	131
NPK Zn Fe Mn + S	1.06	1	25.5	28	145	139
NPK Zn Fe Mn + B	1.11	1.11	28	30	156	148
NPK Zn Fe Mn + Citric acid	1.18	1.15	29.6	33	166	152
NPK Zn Fe Mn + S + B	1.55	1.2	31.9	36	167	159
NPK Zn Fe Mn + S + Citric acid	1.3	1.29	34	38.5	169	161
NPK Zn Fe Mn + B + Citric acid	1.39	1.41	36	41.5	169.5	163
NPK Zn Fe Mn + + S + B + Citric acid	1.44	1.52	37.5	43.5	172	171
New L.S.D. at 5%	0.03	0.04	1.5	1.8	9.1	7.2

S= Elemental Sulphur
B= Boric acid

Table 3: Effect of Citric acid with some Nutrients on fruit firmness (Ib/inch2) and some chemical quality parameters of Le-Conte pear trees during 2005 and 2006 seasons.

Treatment	Fruit firmness ($Ib/inch^2$)		T.S.S. %		Total sugars %	
	2005	2006	2005	2006	2005	2006
Control	19.3	19.3	11.8	12	8.3	8.4
NPK Zn Fe Mn	19	18.2	12.1	12.3	8.5	8.7
NPK Zn Fe Mn + S	18.6	17.8	12.4	12.6	8.7	9.1
NPK Zn Fe Mn + B	18	17.2	12.7	12.8	9	9.3
NPK Zn Fe Mn + Citric acid	17.7	16.8	13	13.1	9.3	9.6
NPK Zn Fe Mn + S + B	17.2	16.4	13.3	13.5	9.6	10
NPK Zn Fe Mn + S + Citric acid	17	16	13.6	13.7	9.8	10.3
NPK Zn Fe Mn + B + Citric acid	16.7	15.8	13.8	14	10.2	10.5
NPK Zn Fe Mn + + S + B + Citric acid	16.5	15.4	14.1	14.3	10.5	10.8
New L.S.D. at 5%	0.3	0.4	0.2	0.3	0.2	0.2

Table 3: Continued

	Reducing sugars %		Sucrose %		Total acidity%	
Control	6.7	6.2	2.2	2.2	0.392	0.4
NPK Zn Fe Mn	6.7	6.5	1.8	2.2	0.36	0.37
NPK Zn Fe Mn + S	7	6.8	1.7	2.3	0.327	0.34
NPK Zn Fe Mn + B	7.3	7.1	1.7	2.2	0.296	0.33
NPK Zn Fe Mn + Citric acid	7.6	7.4	1.7	2.2	0.266	0.299
NPK Zn Fe Mn + S + B	8	7.8	1.6	2.2	0.236	0.269
NPK Zn Fe Mn + S + Citric acid	8.3	8.1	1.5	2.2	0.203	0.221
NPK Zn Fe Mn + B + Citric acid	8.6	8.4	1.6	2.1	0.196	0.2
NPK Zn Fe Mn + + S + B + Citric acid	9	8.6	1.5	2.2	0.193	0.184
New L.S.D. at 5%	0.2	0.2	NS	NS	0.03	0.03

S= Elemental Sulphur
B= Boric acid

citric acid, B or S aside from NPK Zn Fe Mn, in decreasing order gave satisfactory promotion on these nutrients. The lowest values were recorded on the untreated trees. Supplying the trees with NPK Zn Fe Mn B S plus citric acid effectively maximized these nutrients. Similar results were announced in both seasons.

The stimulating effect of the studied nutrients and citric acid on formation of roots which encouraging the translocation of nutrients from soils via roots Nijjar,[3] could explain the present results.

These results are in concordance with those obtained by Ahmed *et al.,*[28] on different nutrients and Ahmed and Morsy[27] on some antioxidants.

Effect of Spraying Some Nutrients and Citric Acid on Yield: As shown in Table (2) , yield of Le- Conte pear trees was positively affected by foliar application of NPK Zn Fe Mn either alone or in combinations with S, B or citric acid. Adding citric acid B, or S to NPK Zn Fe Mn solutions, in descending order was favourable in improving the yield. Combined applications of these nutrients aside from NPK Zn Fe Mn was favourable than using NPK Zn Fe Mn alone.

Application of all nutrients with citric acid gave the maximum yield (37. 5 and 43.5 kg) in 2005 and 2006 seasons. The minimum values of the yield (20 and 23 kg / tree) were recorded on untreated trees. These results were true in both seasons.

The stimulation on growth and nutritional status of the trees in response to application of nutrients and citric acid surely reflected on improving the yield.

Similar results were obtained by Ahmed and Morsy[27] on different nutrients, Ahmed *et al.,*[19] on boron and Ahmed and Abdelaal[13] on citric acid.

Effect of Spraying Some Nutrients and Citric Acid on Fruit Quality: It is evident from the data in Tables (2 & 3) that spraying Le- Conte pear trees with NPK Zn Fe Mn either singly or in combination with B, S or citric acid was followed by significant promotion on fruit quality in terms of increasing fruit weight, total soluble solids %, and total and reducing sugars and in decreasing fruit firmness and total acidity as compared with unspraying ones. Fruit was greatly improved in the trees that were sprayed with all nutrients and citric acid than in those sprayed with NPK Zn Fe Mn only As a conclusion combined spray of N P K Zn Fe Mn S B and citric acid four times was favourable in improving both yield and fruit quality of Le- Conte pear trees.

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