

## **RESPONSE OF LE-CONTE PEAR TREES GROWN UNDER EGYPTIAN CODITION TO SOME FOLIAR APPLICATIONS AND SOIL SPRAYING WITH AGAR SOLUTION.**

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### **ABSTRACT**

The present investigation was carried out during two successive seasons of 2008 and 2009 at El-Kassasin Research Station (sandy loam soil) under drip irrigation system, on Le-Conte pear trees.

The work aimed at studying the effectiveness of foliar application treatments with soluble K<sub>2</sub>SO<sub>4</sub> (SOP), putrescine, chelated micronutrients (Fe + Zn + Mn) solely or in combination and soil spray treatment with Agar solution (as soil conditioner) in improving pear vegetative growth, fruit yield and its quality.

The obtained results showed a pronounced enhancement in the studied vegetative growth characters (No. of leaves and leaf area), chlorophyll (A), chlorophyll (B) and carotene contents as a result of foliar spray treatments. Moreover, these treatments corrected the nutritional status of trees leading to significant increases in fruit yield and an improvement in fruit quality characters (fruit weight, size, firmness, total soluble solids (TSS), acidity, and TSS/acidity ratio).

The best results were obtained with the treatment of combination between "potassium + putrescine + micronutrients" which achieved percentage increases over control; 24.5% in fruit yield, 12.6% in fruit weight and 13.4% in fruit size.

This investigation also showed a promising result concerning using Agar solution, as a soil conditioner. Such treatment exhibited positive responses in all the studied growth parameters and fruit yield. Yet, it might need more time than two seasons in order to have remarkable beneficial effects; as a soil conditioner, being used under drip irrigation system.

### **INTRODUCTION**

In Egypt, Le-Conte pear is the most important pear cultivar. Its trees growth, productivity and fruit quality are greatly influenced by many factors.

Among these factors, is micronutrient deficiency, especially in newly reclaimed soils. It could be considered one of the limiting factors for many fruit trees productivity. In this connection, several investigators have emphasized the great importance and significant influences of foliar application of micronutrients on deciduous fruit trees under soil conditions of Egypt (Awad and Atawia, 1995 a & b; Kabeel *et al.* 1998; Fawzy and Abdel-Moneim, 2004 and El-Sheikh *et al.* 2007).

In addition, the practical use of the diamine putrescine (as a foliar spray solution) had an outstanding influence on yield as well as on physical and chemical properties of many fruits and field crops specially when was sprayed in combination with micronutrients. Such influence was reported by Smith (1985) and Abu El-Fotoh *et al.* (2006) on wheat and rice crops, Abd El-

Magid *et al.* (2007) on cotton and Sayed *et al.* (2008) on orange trees. Altman and Bachrach (1981); Slocum *et al.* (1984); Smith (1985) and Kaur-Sawhney *et al.* (1987) reported that putrescine has a crucial role in protecting cell membranes against the stress injuries caused by cold, salinity, wilting, herbicides and pollution.

It is commonly accepted that potassium soil application enhances fruit yields and its fruit quality specially in poor coarse textured soils (Kilany and Kilany, 1991 and Attala, 1997) on Anna apple. However, it is interesting to mention, under Egyptian conditions, that usage of soluble potassium sulphate as foliar application exhibited significant results in increasing yields and improving fruit quality of many fruit crops (Khamis *et al.* 1994) on peach and pears; (El-Sherif *et al.* 2000) on guava and (Naiema, 2003) on Anna apple.

Few decades ago, considerable attention was focused on using natural polysaccharides as effective agents in stabilizing soil organic matter and clay aggregates. Many researchers have used them as soil conditioners (Wallace, 1986 a & b; Mitchell, 1986 and Ben-Hur and Letey, 1989). Recently, El-Aggory *et al.* (2002) successfully used the biopolymer Agar solution as a spray on sandy soils of Egypt. They concluded that Agar could significantly increase peanut yield.

This work was conducted to study the effect of foliar spraying with chelated micronutrients (Fe, Zn and Mn), putrescine (PUT) and soluble k (SOP), either solely or in combination as well as soil spray treatment with Agar solution, on Le-Conte pear growth, its fruit yield and quality, under Egyptian conditions.

## MATERIALS AND METHODS

This investigation was implemented during consecutive seasons of 2008 and 2009 on healthy Le-Conte pear trees of about 6 years old, budded on *Pyrus communis* rootstock and planted at 5x5m apart. Trees were grown on sandy loam soil under drip irrigation system at El-Kassasin Horticulture Experimental Research Station (30° '11 N, 31° '18 E), Ismailia Governorate, Egypt. All the studied trees were equally subjected to the same N, P, and K fertilization practices. N was added as ammonium Nitrate (33.5 % N) at a rate of 450 N g /tree/year, P was added as superphosphate (15.5% P<sub>2</sub>O<sub>5</sub>) at a rate of 80 P<sub>2</sub>O<sub>5</sub> g/tree/year and K was added as potassium sulphate (48 % K<sub>2</sub>O) at a rate of 900 K<sub>2</sub>O g/tree/year.

In January, organic manure fertilizer + a mixture of whole dose of P-fertilizer, half dose of K-fertilizer and 210 g N of N-fertilizer were applied for each tree. The second half of K- fertilization was applied in May. While, the rest of N-fertilizer was applied at 8 equal doses from mid February to mid September.

Some properties of the experimental soil are shown in Table (1).

**Table (1): Some chemical properties of the experimental soil.**

| pH   | EC<br>dsm <sup>-1</sup><br>1:5 | CaCO <sub>3</sub><br>% | OM<br>% | Available macronutrients<br>mg/kg |      |       | Available micronutrients<br>mg/kg |      |     |     |
|------|--------------------------------|------------------------|---------|-----------------------------------|------|-------|-----------------------------------|------|-----|-----|
|      |                                |                        |         | N                                 | P    | K     | Fe                                | Zn   | Mn  | Cu  |
| 7.90 | 3.50                           | 6.25                   | 0.50    | 58.6                              | 9.50 | 190.5 | 3.2                               | 0.35 | 7.2 | 0.4 |

A split plot design was used to distribute two main plots for soil treatments and eight subplots for foliar spray treatments. The two soil treatments were either sprayed with Agar solution or without Agar. Agar was added as 1g /L, soil of each tree received 4L at the beginning of the season.

Foliar spray treatments were performed 3 times/season; at the end of February and March, and mid of April. Each treatment was replicated three times and each replicate was represented by three trees.

The foliar spray treatments were :

- 1- Control; sprayed with water.
- 2- Potassium sulphate solution SOP"K" [soluble K<sub>2</sub>SO<sub>4</sub>, 50 % K]; applied as 2.0 g/L.
- 3-Putrescine (PUT) [1,4-diaminobutane dihydrochloride]; applied as 10µmole /L.
- 4-Micronutrients solution; containing (Fe + Zn + Mn) (MIC); 0.2g of each/L in chelated EDTA form.
- 5- PUT + K      6- MIC + PUT
- 7- MIC + K      8- MIC + PUT + K

The treated trees were checked up for the following characters:

**Vegetative growth:**

**No. of leaves/shoot:** (recorded at the season end; in August).

**Leaf area:** after harvest time, twenty mature leaves [the third one from the base of the tagged, non fruiting, shoots] were collected for estimating leaf area using area meter (model cl-203, USA).

**Chemical analyses:**

Leaf chlorophyll (A&B) and carotene contents as mg/g f.w. of mature leaf tissue were estimated according to Metzner *et al.* (1965).

**Leaf nutrient contents:** thirty leaves from each replicate, were dried at 70°, ground and digested by a mixture of H<sub>2</sub>SO<sub>4</sub> and HClO<sub>4</sub>, to determine mineral nutrients. N was determined by micro-kjeldahl as described by A.O.A.C. (1980). P was detected spectrophotometrically using molybdate-stannous chloride method and K by flame photometer according to Chapman and Pratt (1978). Fe, Mn, Zn and Cu were determined by Atomic Absorption (model GBC 932).

**Fruit yield per tree:** fruits were harvested at maturity stage (the end of August). Fruit yield (kg) per tree was recorded.

**Fruit quality properties:** representative fruit samples were taken from the **tested trees (15 fruits/replicate) for the following determinations:**

**Physical properties:** including average fruit weight (gm) , average fruit size (cm<sup>3</sup>) and Fruit firmness (lb/inch<sup>2</sup>); being measured by using penetrometer (pressure tester).

**Chemical properties:**

- a- Total soluble solids (TSS); measured by using a carlreiss refractometer.
- b- Percentage of total acidity; determined as malic acid (g/100g fresh weight) according to (A.O.A.C., 1980).
- c- Nutrient contents; N, P, K, Fe, Mn, Zn and Cu in the digested solution of pear fruits of the second year, were determined by methods as previously mentioned.

The obtained data were statistically analysed for the split plot design according to (Snedecor and Cochran, 1980).

## RESULTS AND DISCUSSION

### Response of pear to the foliar spray treatments: Vegetative growth and chemical composition.

Regardless of the effect of soil spraying with Agar, data in Table (2) show clearly that foliar application of K, PUT or MIC solutions, applied solely or in combination, resulted in significant growth increases and markedly enhanced the studied vegetative growth characters namely; No. of leaves/shoot and leaf area. Also, they significantly increased chlorophyll (A), chlorophyll (B) and carotene contents, as compared to control treatment.

It is interesting to note that the overwhelming responses of the previously mentioned parameters were obtained when the three treatments were sprayed in combination; "MIC + PUT + K". The foliar treatments of the dual combinations came at the second rank, followed the order of "PUT + K  $\geq$  "MIC + PUT"  $\geq$  MIC + K". And finally the three individual sprays showed a descending order of PUT > MIC  $\geq$  K.

In general, the responses of the studied characters had the same trend at both seasons. The means of increase percentage achieved by the "MIC+ PUT+ K" treatment over control, for the two seasons, in number of leaves / shoot, leaf area, chlorophyll (A), chlorophyll (B) and carotene contents were 39.0, 26.8, 39.3, 46.8 and 43.4 %, respectively.

The putrescine individual treatment achieved percentage increments of about 17.2, 12.4, 27.7, 4.6, 15.3 % for the respective characters over control. While the same increase percentages due to "MIC" treatment were about 10.0, 7.2, 15.4, 8.9, 8.4 %, respectively.

Concerning the positive effect of "PUT" on growth characters of pear, the obtained results, in this study, are in agreement with those obtained by Sayed *et al.* (2008). They pointed out the role of PUT in improving several fruit tree growth. The enhancement effect of PUT on growth of pear could be attributed to its implication in the synthesis of macro-molecules which are known to increase nucleic acids and stimulate various processes associated with the syntheses of protein (Willadino *et al.* 1996). It might act as plant growth substances (Bagni and Torrigiani (1992), or promote cell division (Smith, 1985).

Regarding micronutrients effect, it is well known that in arid or semiarid soils, being characterized by higher pH, lower organic matter and higher Ca-carbonate content, nutritional imbalance and micronutrient unavailability could prevail. Therefore, foliar application of micronutrients (Fe, Zn, Mn, ....) either separately or in conjunction could result in significant enhancing in the nutritional status of many higher plants, and consequently the vegetative growth characters (El-Kassas *et al.* 1987). Our results are in agreement with those findings of many reporters in Egypt; Mohsen *et al.* (1992) and Sayed (1998) on Balady mandarin and orange, Eissa (1997), Morales *et al.* (2000) and Fawzy (2007) on le Conte pear.

The obtained data showed that K- spraying resulted in percentage increases, in the studied vegetative growth characters and chlorophyll and carotene contents ranged from 3.7 to 7.4 %.



Knowing that macro-nutrients including "K" should be applied to soils, yet The responses exhibited by the vegetative growth characters and chemical composition, in the current study, resulted from foliar K-treatment could be related to the insufficiency of K in the cultivated soil. Our results resemble those reported by (Sharma *et al.* 1992; El-Sherif *et al.* 2000 and Dutta, 2004) on guava and (Doroshenko *et al.* 2005) on apple grown on similar soil.

**Leaf nutrient contents**

Table (3) and Table (4) show that the mean values of the mineral nutrient's concentrations of N, P, K, Fe, Mn, Zn and Cu were increased in pear leaves under all treatments, foliar and soil-spraying, comparing to control.

The obtained results suggest that foliar application of the combined treatment; " MIC+ PUT + K " gave promising results in correcting the nutritional status of pear trees under the experimental conditions.

These results are in harmony with those obtained by Fowzy *et al.* (2007) on pear trees, who attributed the improvement of pear yield to the promoted higher synthesis of metabolites. Similar results were reported by Ahmed *et al.* (1997) and Sayed *et al.* (2008).

**Table (3): Macronutrient contents in Le-Conte pear leaves as affected by foliar application of K, PUT and MIC, and soil spraying with Agar solution.**

| Year      | 2008  |         |          |       |         |          |       |      |          |
|-----------|-------|---------|----------|-------|---------|----------|-------|------|----------|
|           | N (%) |         |          | P (%) |         |          | K (%) |      |          |
|           | Agar  |         | Mean (B) | Agar  |         | Mean (B) | Agar  |      | Mean (B) |
| Without   | With  | Without |          | With  | Without |          | With  |      |          |
| Control   | 1.092 | 1.729   | 1.411    | 0.193 | 0.204   | 0.199    | 1.08  | 1.30 | 1.23     |
| SOP"K"    | 1.458 | 2.092   | 1.775    | 0.203 | 0.253   | 0.228    | 1.40  | 1.50 | 1.45     |
| Put       | 1.274 | 2.184   | 1.729    | 0.237 | 0.261   | 0.249    | 1.28  | 1.45 | 1.37     |
| Mic       | 1.274 | 2.002   | 1.638    | 0.231 | 0.245   | 0.238    | 1.25  | 1.40 | 1.33     |
| Put + K   | 1.638 | 2.092   | 1.865    | 0.228 | 0.264   | 0.251    | 1.48  | 1.50 | 1.49     |
| Mic + Put | 1.729 | 2.184   | 1.957    | 0.227 | 0.248   | 0.238    | 1.30  | 1.48 | 1.39     |
| Mic + K   | 1.638 | 2.002   | 1.820    | 0.234 | 0.250   | 0.242    | 1.33  | 1.48 | 1.41     |
| Mic+Put+K | 1.820 | 2.184   | 2.002    | 0.238 | 0.268   | 0.2353   | 1.45  | 1.50 | 1.48     |
| Mean (A)  | 1.490 | 2.059   | -        | 0.220 | 0.249   | -        | 1.32  | 1.44 | -        |
| Year      | 2009  |         |          |       |         |          |       |      |          |
| Control   | 1.184 | 1.547   | 1.365    | 0.248 | 0.272   | 0.260    | 1.15  | 1.35 | 1.25     |
| SOP"K"    | 1.456 | 2.093   | 1.775    | 0.280 | 0.288   | 0.284    | 1.45  | 1.50 | 1.48     |
| Put       | 1.547 | 1.729   | 1.638    | 0.328 | 0.348   | 0.338    | 1.30  | 1.35 | 1.33     |
| Mic       | 1.638 | 2.093   | 1.866    | 0.329 | 0.356   | 0.343    | 1.25  | 1.35 | 1.30     |
| Put + K   | 1.820 | 2.002   | 1.911    | 0.340 | 0.350   | 0.345    | 1.48  | 1.50 | 1.49     |
| Mic + Put | 1.729 | 2.002   | 1.866    | 0.342 | 0.358   | 0.350    | 1.28  | 1.40 | 1.34     |
| Mic + K   | 1.820 | 2.204   | 2.012    | 0.340 | 0.348   | 0.344    | 1.46  | 1.50 | 1.48     |
| Mic+Put+K | 2.002 | 2.184   | 2.093    | 0.338 | 0.358   | 0.348    | 1.48  | 1.50 | 1.49     |
| Mean (A)  | 1.649 | 1.982   | -        | 0.318 | 0.335   | -        | 1.36  | 1.43 | -        |

**Table (4): Micronutrient contents in Le-Conte pear leaves as affected by foliar application of K , PUT and MIC, and soil spraying with Agar solution.**

| Year      | 2008     |      |          |          |      |          |          |      |          |          |      |          |
|-----------|----------|------|----------|----------|------|----------|----------|------|----------|----------|------|----------|
| Character | Fe mg/kg |      |          | Mn mg/kg |      |          | Zn mg/kg |      |          | Cu mg/kg |      |          |
|           | Agar     |      | Mean (B) | Agar     |      | Mean (B) | Agar     |      | Mean (B) | Agar     |      | Mean (B) |
| Treatment | Without  | With |          | Without  | With |          | Without  | With |          | Without  | With |          |
| Control   | 477      | 503  | 490      | 58       | 86   | 72       | 32       | 42   | 37       | 13       | 19   | 16       |
| SOP"K"    | 581      | 603  | 592      | 61       | 95   | 78       | 53       | 48   | 50.5     | 19       | 21   | 20       |
| Put       | 543      | 529  | 536      | 72       | 98   | 85       | 54       | 58   | 56       | 15       | 16   | 15.5     |
| Mic       | 575      | 631  | 603      | 82       | 102  | 92       | 39       | 46   | 42.5     | 12       | 18   | 15       |
| Put + K   | 595      | 614  | 605      | 66       | 92   | 79       | 51       | 54   | 52.5     | 10       | 15   | 12.5     |
| Mic + Put | 577      | 593  | 585      | 70       | 104  | 87       | 30       | 43   | 36.5     | 14       | 20   | 17       |
| Mic + K   | 590      | 624  | 607      | 71       | 103  | 87       | 37       | 47   | 42       | 10       | 22   | 16       |
| Mic+Put+K | 641      | 643  | 642      | 78       | 118  | 98       | 36       | 49   | 42.5     | 12       | 16   | 14       |
| Mean (A)  | 573      | 589  | -        | 70       | 100  | -        | 41.5     | 48.4 | -        | 13.1     | 18.3 | -        |
| Year      | 2009     |      |          |          |      |          |          |      |          |          |      |          |
| Control   | 426      | 443  | 435      | 81       | 109  | 95       | 32       | 35   | 33.5     | 13       | 17   | 15       |
| SOP"K"    | 479      | 508  | 494      | 87       | 117  | 102      | 34       | 38   | 36       | 16       | 19   | 17.5     |
| Put       | 436      | 579  | 458      | 106      | 119  | 113      | 36       | 39   | 37.5     | 15       | 18   | 16.5     |
| Mic       | 528      | 585  | 557      | 93       | 164  | 129      | 37       | 47   | 42       | 17       | 19   | 18       |
| Put + K   | 513      | 578  | 546      | 95       | 137  | 116      | 33       | 43   | 38       | 18       | 19   | 18.5     |
| Mic + Put | 476      | 575  | 527      | 104      | 165  | 135      | 40       | 61   | 50.5     | 17       | 20   | 18.5     |
| Mic + K   | 487      | 597  | 542      | 86       | 180  | 133      | 39       | 68   | 53.5     | 20       | 21   | 20.5     |
| Mic+Put+K | 446      | 522  | 484      | 155      | 173  | 164      | 52       | 69   | 60.5     | 19       | 21   | 20.0     |
| Mean (A)  | 474      | 536  | -        | 101      | 146  | -        | 37.9     | 50   | -        | 16.9     | 19.3 | -        |

**Fruit yield and quality:**

Concerning the fruit yield (kg/tree), data in Table (5) show that, in both seasons, all the foliar treatments gave significant responses in comparison with the control treatment.

The mean increase percentages of yield, for both seasons, over control treatment, were as follows: 24.5% for (MIC+PUT+K), 23.7% for (K+PUT), 14.2% for (MIC+PUT), 12.4% for (PUT), 11.3% for (MIC+K), 9.8% for (K) and 8.0% for (MIC).

Nevertheless, it is of importance to note that the yield increases which were obtained due to these treatments at the second season were more higher than those of the same treatments at the first season. This could be probably due to the residual effects of the first season treatments.

The same trend generally holds true for fruit weight and fruit size (Table 5).

Such significant increases of fruit yield, resulted from the foliar treatments, were achieved as a logical beneficial effect of these treatments on the vegetative growth.

In this regard, Smith (1985) attributed the efficiency of PUT to its role in stimulating biosynthetic interactions, cell division and fruit set. Moreover, Martin-Tanguy *et al.* (1982), Crisosto *et al.* (1988) and Kaur-Sawhney *et al.* (1990) indicated that putrescine and polyamines seem to play a regulatory role in morphogenetic preceding fruit set through the formation of the flowers and enhancing pollen germination and fertilization. Putrescine efficiency on

increasing pear yield and fruit size was reported by Crisosto *et al.* (1988) and Franco-Mora *et al.* (2005).

**Table (5): Effect of foliar application of K, PUT and MIC and soil spraying with Agar solution on fruit yield and some fruit physical properties of Le-Conte pear.**

| Year                      | 2008                   |       |       |                  |        |        |                               |        |        |  |       |       |
|---------------------------|------------------------|-------|-------|------------------|--------|--------|-------------------------------|--------|--------|--|-------|-------|
| Character                 | Fruit yield /tree (kg) |       |       | Fruit weight (g) |        |        | Fruit size (cm <sup>3</sup> ) |        |        | Fruit firmness (lb/inch <sup>2</sup> ) |       |       |
|                           | Agar                   |       | Mean  | Agar             |        | Mean   | Agar                          |        | Mean   | Agar                                   |       | Mean  |
| Treatment                 | Without                | With  | (B)   | Without          | With   | (B)    | Without                       | With   | (B)    | Without                                | With  | (B)   |
| Control                   | 39.43                  | 40.36 | 39.89 | 142.07           | 144.65 | 143.36 | 163.97                        | 158.00 | 160.99 | 19.12                                  | 19.55 | 19.34 |
| SOP"K"                    | 42.33                  | 42.91 | 42.62 | 150.32           | 150.98 | 150.65 | 170.41                        | 170.39 | 170.40 | 16.39                                  | 16.63 | 16.51 |
| Put                       | 42.78                  | 43.08 | 42.93 | 152.90           | 153.38 | 153.14 | 170.41                        | 170.70 | 170.56 | 18.06                                  | 17.99 | 18.03 |
| Mic                       | 40.81                  | 40.99 | 40.90 | 146.79           | 147.70 | 147.25 | 157.86                        | 158.29 | 158.07 | 18.19                                  | 19.08 | 19.00 |
| Put + K                   | 46.27                  | 49.21 | 47.74 | 157.07           | 157.62 | 157.35 | 177.14                        | 178.17 | 177.66 | 17.68                                  | 17.39 | 17.60 |
| Mic + Put                 | 44.28                  | 44.46 | 44.37 | 155.13           | 155.45 | 155.29 | 174.19                        | 174.69 | 174.44 | 17.57                                  | 17.63 | 16.41 |
| Mic + K                   | 42.13                  | 43.51 | 42.82 | 154.06           | 153.96 | 154.01 | 173.73                        | 175.14 | 174.43 | 16.66                                  | 16.16 | 17.23 |
| Mic+Put+K                 | 48.12                  | 48.66 | 48.39 | 160.41           | 160.14 | 160.27 | 179.70                        | 180.28 | 179.99 | 17.51                                  | 16.96 | 17.23 |
| Mean (A)                  | 43.27                  | 44.15 | -     | 152.35           | 152.99 | -      | 170.93                        | 170.71 | -      | 17.74                                  | 17.69 | -     |
| L.S.D <sub>0.05</sub> A   | N.S                    |       |       | 0.38             |        |        | N.S                           |        |        | N.S                                    |       |       |
| L.S.D <sub>0.05</sub> B   | 1.90                   |       |       | 1.44             |        |        | 4.23                          |        |        | 0.71                                   |       |       |
| L.S.D <sub>0.05</sub> AxB | 2.69                   |       |       | 2.03             |        |        | 5.99                          |        |        | 1.00                                   |       |       |
| Year                      | 2009                   |       |       |                  |        |        |                               |        |        |  |       |       |
| Control                   | 37.42                  | 38.76 | 38.09 | 141.74           | 144.65 | 143.19 | 158.01                        | 156.87 | 157.44 | 19.42                                  | 19.39 | 19.41 |
| SOP"K"                    | 42.23                  | 43.62 | 42.92 | 149.51           | 150.36 | 149.93 | 170.77                        | 171.51 | 171.14 | 17.22                                  | 16.89 | 17.05 |
| Put                       | 44.06                  | 45.32 | 44.69 | 152.66           | 153.29 | 152.97 | 171.0                         | 172.09 | 171.56 | 17.57                                  | 18.14 | 17.86 |
| Mic                       | 42.80                  | 43.67 | 43.24 | 146.94           | 147.42 | 147.18 | 158.89                        | 160.25 | 159.57 | 18.42                                  | 18.72 | 18.57 |
| Put + K                   | 48.79                  | 48.73 | 48.76 | 156.52           | 157.33 | 156.92 | 177.08                        | 178.24 | 177.66 | 17.32                                  | 17.41 | 17.36 |
| Mic + Put                 | 44.33                  | 45.23 | 44.64 | 154.42           | 155.65 | 155.04 | 174.08                        | 174.98 | 174.53 | 17.80                                  | 17.31 | 17.56 |
| Mic + K                   | 43.50                  | 44.28 | 43.89 | 153.86           | 154.45 | 154.16 | 175.70                        | 176.47 | 176.09 | 15.75                                  | 16.20 | 15.98 |
| Mic+Put+K                 | 48.18                  | 49.26 | 48.72 | 161.97           | 162.53 | 162.25 | 179.91                        | 181.87 | 180.89 | 16.67                                  | 15.41 | 16.04 |
| Mean (A)                  | 43.89                  | 44.86 | -     | 152.20           | 153.21 | -      | 170.66                        | 171.54 | -      | 17.52                                  | 17.44 | -     |
| L.S.D <sub>0.05</sub> A   | N.S                    |       |       | 1.17             |        |        | N.S                           |        |        | N.S                                    |       |       |
| L.S.D <sub>0.05</sub> B   | 1.89                   |       |       | 1.78             |        |        | 2.27                          |        |        | 0.83                                   |       |       |
| L.S.D <sub>0.05</sub> AxB | 2.68                   |       |       | 2.51             |        |        | 3.21                          |        |        | 1.18                                   |       |       |

The stimulated effects of K-foliar application, on fruit yield, were reported by Khamis *et al.* (1994); Wani *et al.* (1997); El-Sherif *et al.* (2000) and Dutta (2004). They emphasized that K-foliar application has a significant effect on increasing fruit yield and size of apple, pear and guava.

Concerning micronutrients spraying effects, some workers demonstrated that they have great enhancing responses on pear fruit yield and its quality; being grown on soils of low micronutrients content, low O.M and high pH (Awad and Atawia, 1995; Eissa, 1997 and Wojcik and Popinska, 2009).

**Fruit quality :**

**Fruit physical properties:**

In this regard, the average fruit weight (g), fruit size (cm<sup>3</sup>) and fruit firmness (L/b<sup>2</sup>) were all responded significantly to foliar spray treatments. Data presented in Table (5) reveal clearly that, all treatments gave markedly

higher values of fruit weight and size, but obviously lower desirable values of fruit firmness; comparing to control.

The favorable response of fruit physical properties took the same trend of fruit yield. Thus, the treatment of "MIC + PUT+ K" gave the best fruit physical properties.

**Fruit chemical properties :**

Data presented in Table (6) display fruit TSS (%), Fruit acidity (%) and TSS/Acidity ratio, in response to the spray treatments. The obtained data reveal that all foliar treatments could achieve significant improvement effect comparing to control. Not only such foliar treatments affected fruit size and its weight but also their mineral contents, Table (7 and 8).

The improvement in both physical and chemical fruit properties exhibited the same trend of the previously shown fruit yield.

The obtained data of physical and chemical fruit quality are in accordance with those obtained by many investigators. El-Kassas *et al.* (1987) reported that micronutrients foliar spray on mandarin tree elevated fruit TSS %, and reduced total acidity of fruits.

**Table (6): Effect of foliar application of K, PUT and MIC and soil spraying with Agar solution on some fruit chemical properties of Le-Cont pear.**

| Year                      | 2008            |         |          |                   |         |          |                       |       |          |
|---------------------------|-----------------|---------|----------|-------------------|---------|----------|-----------------------|-------|----------|
|                           | Fruit T.S.S.(%) |         |          | Fruit acidity (%) |         |          | T.S.S./ acidity RATIO |       |          |
|                           | Agar            |         | Mean (B) | Agar              |         | Mean (B) | Agar                  |       | Mean (B) |
| Without                   | With            | Without |          | With              | Without |          | With                  |       |          |
| Control                   | 10.66           | 10.31   | 10.49    | 0.253             | 0.267   | 0.260    | 42.07                 | 38.75 | 40.41    |
| SOP"K"                    | 11.38           | 11.34   | 11.36    | 0.207             | 0.210   | 0.208    | 55.05                 | 55.03 | 5.04     |
| Put                       | 11.07           | 11.19   | 11.13    | 0.220             | 0.227   | 0.223    | 50.42                 | 49.36 | 49.89    |
| Mic                       | 11.99           | 12.07   | 12.04    | 0.227             | 0.230   | 0.228    | 53.02                 | 52.24 | 52.63    |
| Put + K                   | 12.82           | 12.99   | 12.91    | 0.213             | 0.210   | 0.212    | 60.26                 | 61.94 | 61.10    |
| Mic + Put                 | 12.81           | 12.93   | 12.87    | 0.243             | 0.237   | 0.240    | 51.89                 | 54.65 | 53.27    |
| Mic + K                   | 11.95           | 12.40   | 12.18    | 0.233             | 0.237   | 0.235    | 51.35                 | 52.41 | 51.88    |
| Mic+Put+K                 | 14.02           | 14.63   | 14.33    | 0.203             | 0.200   | 0.202    | 66.99                 | 73.15 | 70.07    |
| Mean (A)                  | 12.09           | 12.23   | -        | 0.225             | 0.227   | -        | 53.88                 | 54.69 | -        |
| L.S.D <sub>0.05</sub> A   | N.S             |         |          | N.S               |         |          | N.S                   |       |          |
| L.S.D <sub>0.05</sub> B   | 0.28            |         |          | 0.010             |         |          | 2.69                  |       |          |
| L.S.D <sub>0.05</sub> AxB | 0.40            |         |          | 0.014             |         |          | 3.81                  |       |          |
| Year                      | 2009            |         |          |                   |         |          |                       |       |          |
| Control                   | 10.24           | 10.07   | 10.16    | 0.287             | 0.293   | 0.290    | 35.78                 | 34.34 | 35.06    |
| SOP"K"                    | 11.09           | 11.09   | 11.09    | 0.273             | 0.267   | 0.270    | 40.71                 | 41.63 | 41.17    |
| Put                       | 10.99           | 11.32   | 11.15    | 0.277             | 0.267   | 0.272    | 39.76                 | 42.68 | 41.22    |
| Mic                       | 12.40           | 12.61   | 12.28    | 0.273             | 0.277   | 0.275    | 45.61                 | 43.96 | 44.79    |
| Put + K                   | 11.53           | 11.83   | 11.68    | 0.267             | 0.257   | 0.262    | 43.22                 | 46.19 | 44.71    |
| Mic + Put                 | 12.67           | 12.89   | 12.78    | 0.253             | 0.240   | 0.247    | 50.01                 | 53.77 | 51.89    |
| Mic + K                   | 13.02           | 12.98   | 13.00    | 0.247             | 0.233   | 0.240    | 53.11                 | 56.64 | 54.88    |
| Mic+Put+K                 | 14.28           | 14.14   | 14.21    | 0.207             | 0.207   | 0.207    | 68.08                 | 68.56 | 68.32    |
| Mean (A)                  | 12.03           | 12.06   | -        | 0.260             | 0.255   | -        | 47.04                 | 48.47 | -        |
| L.S.D <sub>0.05</sub> A   | N.S             |         |          | N.S               |         |          | N.S                   |       |          |
| L.S.D <sub>0.05</sub> B   | 0.46            |         |          | 0.015             |         |          | 3.69                  |       |          |
| L.S.D <sub>0.05</sub> AxB | 0.65            |         |          | 0.021             |         |          | 5.22                  |       |          |

**Table (7): Macronutrient contents in Le-Conte pear fruits as affected by foliar application of K, PUT, and MIC, and soil spraying with Agar solution.**

| Year      | 2008    |       |          |         |       |          |         |      |          |
|-----------|---------|-------|----------|---------|-------|----------|---------|------|----------|
|           | N (%)   |       |          | P (%)   |       |          | K (%)   |      |          |
|           | Agar    |       | Mean (B) | Agar    |       | Mean (B) | Agar    |      | Mean (B) |
|           | Without | With  |          | Without | With  |          | Without | With |          |
| Control   | 0.455   | 0.546 | 0.501    | 0.114   | 0.136 | 0.125    | 0.70    | 0.75 | 0.73     |
| SOP"K"    | 0.546   | 0.637 | 0.592    | 0.140   | 0.161 | 0.151    | 0.80    | 0.90 | 0.85     |
| Put       | 0.628   | 0.728 | 0.678    | 0.147   | 0.167 | 0.157    | 0.78    | 0.85 | 0.82     |
| Mic       | 0.548   | 0.625 | 0.586    | 0.165   | 0.179 | 0.172    | 0.70    | 0.85 | 0.78     |
| Put + K   | 0.638   | 0.728 | 0.683    | 0.158   | 0.173 | 0.166    | 0.85    | 1.05 | 0.95     |
| Mic + Put | 0.637   | 0.728 | 0.683    | 0.177   | 0.186 | 0.182    | 0.75    | 0.80 | 0.78     |
| Mic + K   | 0.625   | 0.728 | 0.677    | 0.179   | 0.189 | 0.184    | 0.80    | 0.90 | 0.85     |
| Mic+Put+K | 0.720   | 0.819 | 0.770    | 0.187   | 0.189 | 0.188    | 0.85    | 1.05 | 0.95     |
| Mean (A)  | 0.599   | 0.692 | -        | 0.158   | 0.173 | -        | 0.78    | 0.89 | -        |

**Table (8): Micronutrient contents in Le-Conte pear fruits as affected by foliar application of K, PUT, and MIC, and soil spraying with Agar solution.**

| Year      | Fe g/kg   |         |          | Mn g/kg |      |          | Zn g/kg |         |          | Cu g/kg |      |          |
|-----------|-----------|---------|----------|---------|------|----------|---------|---------|----------|---------|------|----------|
|           | Agar      |         | Mean (B) | Agar    |      | Mean (B) | Agar    |         | Mean (B) | Agar    |      | Mean (B) |
|           | Without   | With    |          | Without | With |          | Without | With    |          | Without | With |          |
|           | Treatment | Without | With     | Without | With | Without  | With    | Without | With     | Without | With |          |
| Control   | 61        | 68      | 64.5     | 9       | 12   | 12.0     | 13      | 22      | 17.5     | 4       | 5    | 4.5      |
| SOP"K"    | 63        | 70      | 66.5     | 11      | 13   | 11.0     | 16      | 27      | 21.5     | 5       | 8    | 6.5      |
| Put       | 65        | 70      | 67.5     | 10      | 12   | 12.5     | 23      | 29      | 26.0     | 4       | 5    | 4.5      |
| Mic       | 68        | 70      | 69.0     | 10      | 12   | 11.0     | 25      | 31      | 28.0     | 5       | 6    | 5.5      |
| Put + K   | 67        | 73      | 70.0     | 12      | 13   | 12.5     | 21      | 23      | 22.0     | 6       | 6    | 6.0      |
| Mic + Put | 66        | 74      | 70.0     | 10      | 11   | 10.5     | 28      | 30      | 29.0     | 5       | 5    | 5.0      |
| Mic + K   | 73        | 82      | 77.5     | 11      | 12   | 11.5     | 29      | 32      | 30.5     | 6       | 9    | 7.5      |
| Mic+Put+K | 76        | 85      | 80.5     | 10      | 13   | 11.5     | 26      | 34      | 30.0     | 8       | 10   | 9.0      |
| Mean (A)  | 67.4      | 74.0    | -        | 10.4    | 12.3 | -        | 22.6    | 28.5    | -        | 5.4     | 6.8  | -        |

Lofty *et al.* (1990) and El-Sherif *et al.* (2000) showed that spraying potassium sulphate (1, 1.5 or 2%) increased TSS and reduced acidity of guava fruits.

Abd El-Dayem (2001) observed that putrescine spray increased the transport of K and enhanced its translocation into the growing tips, and led to better fruit chemical properties. Similar results also were reported by Sayed *et al.* (2008).

**Response of Le-Conte pear to soil spraying with Agar solution :**

The effects of soil spray treatment with Agar solution are shown in Table (2). It is noticeable that it has a slight positive response in the studied vegetative growth characters and also in the chemical composition of pear leaves.

Table (5) and (6) also, cleared up that pear fruit yield components and quality characters of fruit all positively but not significantly responded to this soil conditioner treatment. This finding could be interpreted as such soil conditioner treatment, might need more time exceeding two seasons to let it reach the root zone of pear trees; through the drip irrigation system.

However, the higher responses obtained in mineral contents of leaves (Table 3 and 4) and fruits (Table 7 and 8) denote the great promising role of Agar solution spray treatment as a soil conditioner in improving fruit yield and quality of pear trees.

In this regard, El-Aggory *et al.* (2002) conducted several experiments using Agar solution as a soil conditioner, and concluded that using the natural biopolymer Agar, was very promising in sandy and calcareous soils. They attributed such response to its stabilizing and jellifying power which causing retention of micronutrients and water around the plants and protecting them against leaching besides, being biologically undegradable.

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استجابة أشجار الكمثرى صنف الليكونت النامية تحت الظروف المصرية إلى بعض معاملات الرش الورقي ورش التربة بمحلول الأجار.  
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أجريت هذه الدراسة خلال موسمي (٢٠٠٨ ، ٢٠٠٩) في أرض محطة بحوث القصاصين (أرض رملية طميية) ، تحت نظام الري بالتنقيط على أشجار كمثرى الليكونت. يهدف هذا البحث إلى دراسة كفاءة معاملة الأشجار بالرش الورقي - باستخدام محلول كبريتات البوتاسيوم الذائبة (SOP)، ومحلول البتروسين، والعناصر الصغرى (حديد - زنك - منجنيز في صورة مخلبية)-بصورة منفردة أو مشتركة، علاوة على المعاملة بالرش بمحلول الأجار على التربة (كمصلح للتربة) على تحسين النمو الخضري للأشجار و المحصول الثمرى وجودته. أظهرت النتائج المتحصل عليها أن هناك زيادة واضحة في صفات النمو الخضري تحت الدراسة (عدد الأوراق / فرع و مساحة الورقة)، ومحتواها من الكلورفيل أ ، ب والكاروتين ) نتيجة لمعاملات الرش الورقي وذلك مقارنة بمعاملة الكنترول، كما أدت هذه المعاملات الى تحسين الحالة الغذائية للأشجار مما نتج عنه زيادة معنوية في كمية محصول ثمار الكمثرى/ شجرة وكذلك حدث تحسن في صفات الثمرة النوعية المتمثلة في وزنها و حجمها و بعض الصفات الطبيعية و الكيميائية . كانت أفضل النتائج المتحصل عليها ناتجة عن المعاملة المشتركة بين الثلاث مركبات للرش (البوتاسيوم + البتروسين + العناصر الصغرى ) حيث حققت زيادة بنسبة مئوية قدرها ٢٤.٥% في محصول الفاكهة/شجرة ، ١٢.٦% في وزن الثمرة و ١٣.٤% فحجمها ؛ عن معاملة الكنترول. وكذلك أظهرت الدراسة نتائج واعدة نتيجة معاملة رش التربة بمحلول الأجار كمصلح للتربة حيث أعطت هذه المعاملة تحسناً ظاهراً في كل مقاييس النمو تحت الدراسة للأشجار ، وكذلك وجد زيادة في محصول الثمار وتحسن صفاتها إلا أنه يبدو من المحتمل أن مثل هذه المعاملة وتحت ظروف التجربة والري بالتنقيط ، تحتاج إلى مزيد من الوقت أكثر من موسمين لتكون أكثر تأثيراً وتحقق نتائج ملموسة.

قام بتحكيم البحث

كلية الزراعة - جامعة المنصورة  
مركز البحوث الزراعية

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**Table (2): Effect of foliar application of K, PUT and MIC, and soil spraying with Agar solution on some vegetative growth characters and chemical composition.**

| Year                      | 2008                |       |          |                              |       |          |                     |       |          |                    |       |          |                    |       |          |
|---------------------------|---------------------|-------|----------|------------------------------|-------|----------|---------------------|-------|----------|--------------------|-------|----------|--------------------|-------|----------|
| Character                 | No. of leaves/shoot |       |          | Leaf area (cm <sup>2</sup> ) |       |          | Chl (A) mg/g f. wt. |       |          | Chl (B) mg/g f. wt |       |          | Carotene mg/g f.wt |       |          |
| Treatment                 | Agar                |       | Mean (B) | Agar                         |       | Mean (B) | Agar                |       | Mean (B) | Agar               |       | Mean (B) | Agar               |       | Mean (B) |
|                           | Without             | With  |          | Without                      | With  |          | Without             | With  |          | Without            | With  |          | Without            | With  |          |
| Control                   | 13.91               | 14.84 | 14.37    | 24.64                        | 25.07 | 24.86    | 0.602               | 0.598 | 0.600    | 0.475              | 0.501 | 0.488    | 0.511              | 0.502 | 0.506    |
| SOP"K"                    | 15.45               | 15.44 | 15.44    | 26.78                        | 26.13 | 26.46    | 0.606               | 0.618 | 0.612    | 0.481              | 0.515 | 0.498    | 0.492              | 0.518 | 0.505    |
| Put                       | 15.95               | 16.45 | 16.20    | 28.04                        | 29.21 | 28.63    | 0.638               | 0.658 | 0.648    | 0.509              | 0.526 | 0.518    | 0.582              | 0.568 | 0.575    |
| Mic                       | 15.16               | 15.71 | 15.43    | 26.00                        | 26.64 | 26.64    | 0.631               | 0.651 | 0.641    | 0.559              | 0.543 | 0.551    | 0.526              | 0.543 | 0.535    |
| Put + K                   | 17.92               | 18.12 | 18.02    | 28.85                        | 29.08 | 28.96    | 0.698               | 0.714 | 0.706    | 0.625              | 0.614 | 0.620    | 0.619              | 0.665 | 0.642    |
| Mic + Put                 | 17.93               | 18.18 | 18.06    | 28.17                        | 29.58 | 28.88    | 0.694               | 0.688 | 0.691    | 0.599              | 0.634 | 0.617    | 0.594              | 0.636 | 0.615    |
| Mic + K                   | 17.08               | 17.50 | 17.29    | 26.75                        | 28.00 | 27.38    | 0.648               | 0.681 | 0.664    | 0.589              | 0.609 | 0.599    | 0.612              | 0.675 | 0.644    |
| Mic+Put+K                 | 19.84               | 20.33 | 20.09    | 30.58                        | 31.87 | 31.23    | 0.717               | 0.729 | 0.723    | 0.685              | 0.715 | 0.700    | 0.662              | 0.722 | 0.692    |
| Mean (A)                  | 16.65               | 17.07 | -        | 27.48                        | 28.20 | -        | 0.651               | 0.667 | -        | 0.565              | 0.582 | -        | 0.575              | 0.604 | -        |
| L.S.D <sub>0.05</sub> A   | N.S                 |       |          | N.S                          |       |          | N.S                 |       |          | N.S                |       |          | 0.014              |       |          |
| L.S.D <sub>0.05</sub> B   | 0.33                |       |          | 1.95                         |       |          | 0.017               |       |          | 0.021              |       |          | 0.023              |       |          |
| L.S.D <sub>0.05</sub> AxB | 0.47                |       |          | 2.76                         |       |          | 0.024               |       |          | 0.029              |       |          | 0.032              |       |          |
| Year                      | 2009                |       |          |                              |       |          |                     |       |          |                    |       |          |                    |       |          |
| Control                   | 14.39               | 14.87 | 14.63    | 25.20                        | 25.15 | 25.18    | 0.484               | 0.522 | 0.503    | 0.493              | 0.491 | 0.492    | 0.511              | 0.527 | 0.519    |
| SOP"K"                    | 15.32               | 15.51 | 15.42    | 25.49                        | 25.82 | 25.16    | 0.589               | 0.604 | 0.597    | 0.483              | 0.546 | 0.515    | 0.569              | 0.593 | 0.581    |
| Put                       | 17.92               | 17.67 | 17.79    | 27.56                        | 28.00 | 27.78    | 0.619               | 0.663 | 0.641    | 0.492              | 0.521 | 0.507    | 0.589              | 0.622 | 0.606    |
| Mic                       | 16.62               | 16.35 | 16.49    | 26.86                        | 27.12 | 26.99    | 0.609               | 0.639 | 0.624    | 0.493              | 0.541 | 0.517    | 0.560              | 0.594 | 0.577    |
| Put + K                   | 18.40               | 18.69 | 18.55    | 30.47                        | 30.93 | 30.70    | 0.739               | 0.769 | 0.754    | 0.671              | 0.693 | 0.682    | 0.723              | 0.753 | 0.738    |
| Mic + Put                 | 18.24               | 18.62 | 18.43    | 29.82                        | 30.67 | 30.25    | 0.694               | 0.756 | 0.725    | 0.636              | 0.658 | 0.647    | 0.671              | 0.723 | 0.697    |
| Mic + K                   | 18.49               | 18.95 | 18.72    | 26.79                        | 27.90 | 27.35    | 0.700               | 0.703 | 0.702    | 0.598              | 0.30  | 0.614    | 0.746              | 0.759 | 0.753    |
| Mic+Put+K                 | 19.70               | 20.78 | 20.24    | 31.72                        | 32.78 | 32.25    | 0.787               | 0.802 | 0.795    | 0.725              | 0.752 | 0.739    | 0.755              | 0.797 | 0.776    |
| Mean (A)                  | 17.39               | 17.68 | -        | 27.99                        | 28.55 | -        | 0.653               | 0.682 | -        | 0.573              | 0.604 | -        | 0.641              | 0.671 | -        |
| L.S.D <sub>0.05</sub> A   | N.S                 |       |          | N.S                          |       |          | 0.026               |       |          | 0.007              |       |          | N.S                |       |          |
| L.S.D <sub>0.05</sub> B   | 1.22                |       |          | 0.87                         |       |          | 0.021               |       |          | 0.032              |       |          | 0.036              |       |          |
| L.S.D <sub>0.05</sub> AxB | 1.73                |       |          | 1.23                         |       |          | 0.029               |       |          | 0.045              |       |          | 0.051              |       |          |