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# EFFECT OF SOME MACRO NUTRIENTS SPRAYS ON MINERAL STATUS, YIELD AND FRUIT QUALITY OF HAMLIN ORANGE TREES GROWN UNDER RAFAH CONDITIONS

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## ABSTRACT

This study wad carried out on mature Hamlin orange trees grown in Rafah orchard located at Northern Siani governorate. The experiment included spraying with urea at 0.5% with two forms of potassium phosphate, (potassium dihydrogen phosphate or dipotassium hydrogen phosphate) each at 1% or 1.5% twice (late May and early August) during 1997 and 1998 seasons.
Aim of The experiment was to show the effect of the sprayed materials on mineral content in leaves, yield and fruit quality.
Results revealed that spraying urea with different forms of potassium raised leaf N,P and K contents and increased yield/tree
Most treatments increased average fruit weight, volume, diameter and juice weight. T.S.S and T.S.S./acid ratio was only increased due to urea + dipotassium hydrogen phosphate in both concentrations. Different treatments decreased juice percentage and ascorbic acid (V.C) than the control in both seasons of this study.
The best results with respect to mineral status, yield and average fruit weight and volume of Hamlin orange trees were obtained due to spraying 0.5% urea + 1.5% dipotassium hydrogen phosphate twice in late May and early August. So, this treatment seems to be promising for Hamlin orange trees under this study.

## INTRODUCTION

It is well known that most of the new reclaimed areas in Egypt are planted with fruit trees specially citrus. Trees grown in sandy soil at Northern Sinai governorate have the problem of low productivity. Under such type of soil which characterized with poor fertility and low water holding capacity, trees are in need to special fertilization regime.
Many previous studies revealed that NPK foliar sprays enhanced nutrional status and improved the yield and quality of different fruit crops. These studies were supported by Shawky et al. (1970), El-Deeb (1989), on oranges and Ibrahim et al. (1993) and El-Fangary (1998) on mandarin.
Therefore, this experiment was carried out in a trial to raise the production of Hamlin orange trees grown at Rafah district through foliar sprays containing a combination of some macro nutrients namely N,P and K.

## MATERIALS AND METHODS

This study was carried out during the two successive seasons of (1997 and 1998) on 20-years old Hamlin orange trees budded on sour orange rootstock and grown in sandy soil at Rafah (Northern Sinai governorate). The trees were planted at 6 X 6 m under basin irrigation system. The other cultural practices were the same for all trees. The results of soil

analysis indicated that pH was 8.3 & E.C. = 0.12 $ds^{-1}$ & $CaCO_{-3}$ was 1.65% & organic matter was 0.35% and the soil texture was sandy.

The experiment involved six foliage spraying treatments as follows:

1. Control (water spraying trees).
2. 0.5% urea.
3. 0.5% urea + 1% potassium dihydrogen phosphate ($KH_2PO_4$).
4. 0.5% urea + 1.5% potassium dihydrogen phosphate ($KH_2PO_4$).
5. 0.5% urea + 1% dipotassium hydrogen phosphate ($K_2HPO_4$).
6. 0.5% urea + 1.5% dipotassium hydrogen phosphate ($K_2HPO_4$).

A complete randomized block design was arranged where each treatment was replicated three times on one tree plots. Each tree was sprayed twice (late May and early August) in each season with 12 liters of the solution which was sufficient to wet it thoroughly.

In late August of each season, fifty leaves from tagged non fruiting and non flushing spring growth cycle were collected, washed with tap water, then with distilled water and dried at 70□C until constant weight and ground to be used for the determination of N according to Pregl et al. (1945), P using the method of Trough and Meyer (1929)**,** K as described by Brown and Lilliland (1946). N, P and K content in the leaves was determined on dry weight basis.

At harvesting time under the experimental conditions (late December), the yield per tree was determined.

For fruit quality a sample of 5 fruits from each tree was taken at harvest to determine average fruit weight, volume, diameter, peel thickness, Juice percentage, total soluble solids percentage, titratable acidity, TSS/acid ratio and ascorbic acid content using the methods described in (A.O.A.C., 1970).

The obtained results were statistically analyzed for comparison among means and least significant difference (L.S.D.) was used, according to Snedecor and Cochran, (1972).

## RESULTS AND DISCUSSION

### 1. Leaf mineral content

Results in Table (1) showed that N,P,K content in Hamlin orange leaves was significantly affected by different treatments in the two seasons. Generally, it was observed that the values of N and P in the leaves were within the (low-optimum) level while, K was within the (optimum-high) level, according to Jones and Embleton, (1969).

Spraying urea alone (treatment٢ ) increased leaf N content significantly in both study seasons when compared with control trees. The values were 1.98% and 2.30% in the first and second season respectively. However, the increment did not rise N in the leaves to the optimum level (2.4-2.6%). On the other hand, N content in the leaves was markedly increased when urea sprays were combined with $KH_2PO_4$ or $K_2HPO_4$ at the low or the high concentration (treatments 3,4,5 and 6). Since the values ranged between (2.10%-2.24%) and (2.5%-2.6%) in the first and second season respectively.

This means that nitrogen in Hamlin orange leaves could be raised to the optimum level by spraying leaves with NPK. This trend was true in the second season.

As for leaf P content, results of the two seasons revealed that different treatments significantly increased P content in the leaves significantly than those of the control, except spraying urea alone (treatment 2) did not increase P content in the leaves significantly.

The values ranged between (0.11% - 0.17%) and (0.12-0.18%) in the first and second season respectively.

Regarding K content in the leaves, results clearly showed that spraying urea alone (treatment 2) increased K in the leaves significantly in both seasons when compared with control trees. However, K values in the leaves ranged between (0.95-1.25%) and (0.92-1.60%) in the first and second season respectively. Spraying with urea + $KH_2PO_4$ at 1 or 1.5% (treatments 3 and 4) gave significant increase in leaf K content than those obtained by spraying urea alone.

Generally, spraying with NPK specially, at 0.5% urea +1 or 1.5% $K_2HPO_4$ (treatments 5 or 6) recorded highest significant values with respect to K content in the leaves when compared with all other treatments. The least K values in leaves where obtained by control trees. The values were (0.95% and 0.92%) in the first and second season respectively.

From the abovementioned results, it could be concluded that mineral status of Hamlin orange trees with respect to N,P and K content in the leaves could be markedly enhanced by NPK sprays specially at 0.5% urea +1 or 1.5% $K_2HPO_4$. Such results could be explained by the simulative effect of urea spraying solution on the uptake of such nutrient elements by vegetative portions Beutal (1962) and Ahmed et al. (1997).

The obtained results are in agreement with those reported by El-Deeb (1989) on Washington navel and Valencia oranges who found that $K_2HPO_4$ foliar sprays enhanced the levels of N,P and K in the leaves.

**Table (1) Effect of spraying NPK on leaf mineral content of Hamlin orange trees during (1997 and 1998 seasons).**

| Treatments | Nitrogen % | | Phosphorus % | | Potassium % | |
|---|---|---|---|---|---|---|
| | **1997** | **1998** | **1997** | **1998** | **1997** | **1998** |
| 1) Control | 1.69 | 1.90 | 0.12 | 0.13 | 0.95 | 0.92 |
| 2) 0.5 % urea | 1.98 | 2.30 | 0.11 | 0.12 | 1.00 | 1.10 |
| 3) 0.5% urea + 1% $KH_2PO_4$ | 2.10 | 2.50 | 0.17 | 0.18 | 1.19 | 1.50 |
| 4) 0.5% urea + 1.5% $KH_2PO_4$ | 2.15 | 2.60 | 0.15 | 0.17 | 1.15 | 1.50 |
| 5) 0.5% urea + 1% $K_2HPO_4$ | 2.24 | 2.56 | 0.15 | 0.17 | 1.25 | 1.60 |
| 6) 0.5% urea + 1.5% $K_2HPO_4$ | 2.22 | 2.56 | 0.16 | 0.16 | 1.21 | 1.57 |
| L.S.D. 5% | 0.09 | 0.12 | 0.02 | 0.02 | 0.05 | 0.07 |

**2. Yield**

It is clear from the data presented in Table (2) that different treatments significantly increased yield either expressed in weight (kgs) or number of fruits per tree in the two seasons when compared with the control. Spraying urea alone (treatment 2) failed to create any beneficial effect on yield as number of fruits per tree than those of the control. The yield values ranged between (45.2-81.0 kgs) and (52.8-82.8 kgs) as weight, (275-450 fruits) and (280-460 fruits) as number per tree in the first and second season respectively.

As for NPK sprays, results showed that spraying trees with 0.5% urea +1.5% $K_2HPO_4$ (treatment 6) was superior and gave the highest yield either as weight or number of fruits per tree in the two seasons followed by treatments (5,4 and 3) in a decreasing order. Since their values ranged between (63.5-81.0 kgs) and (67.2-82.8 kgs) as weight, (420-450 fruits) and (425-460 fruits) as number per tree in the first and second season respectively.

When taking the source of the sprayed materials into consideration, results revealed that yield obtained from trees sprayed with urea + dipotassium hydrogen phosphate (treatments 5 and 6) was better than those obtained from trees sprayed with urea + potassium dihydrogen phosphate (treatments 3 and 4). Similarly, raising the concentration of either $K_2HPO_4$ or $KH_2PO_4$ from 1% to 1.5% in the spraying solution proved to have a positive effect on yield weight and number of fruits per tree. This was true specially in the second season.

**Table (2): Effect of spraying NPK on yield of Hamlin orange trees in (1997 and 1998 seasons).**

| Treatments | Yield/tree (kg) | | Average of the two seasons | No. fruits/tree | | Average of the two seasons |
|---|---|---|---|---|---|---|
| | 1997 | 1998 | | 1997 | 1998 | |
| 1) Control | 31.8 | 34.6 | 33.2 | 290 | 275 | 283 |
| 2) 0.5 % urea | 45.2 | 52.8 | 49.0 | 275 | 280 | 278 |
| 3) 0.5% urea + 1% $KH_2PO_4$ | 63.5 | 67.2 | 65.4 | 420 | 425 | 423 |
| 4) 0.5% urea + 1.5% $KH_2PO_4$ | 66.6 | 69.6 | 68.1 | 430 | 435 | 433 |
| 5) 0.5% urea + 1% $K_2HPO_4$ | 77.9 | 79.6 | 77.2 | 440 | 455 | 448 |
| 6) 0.5% urea + 1.5% $K_2HPO_4$ | 81.0 | 82.8 | 81.9 | 450 | 460 | 455 |
| L.S.D. 5% | 3.6 | 2.4 | 3.2 | 24 | 54 | 19.3 |

To avoid the effect of the season, the average yield weight (kgs) and number of fruits per tree of the two seasons was calculated. The results in (Table 2) showed that similar trend to that obtained in the second season was noticed where highest yield weight (81.9 kgs) and number of fruits (455 fruits/tree) was obtained from trees sprayed with 0.5% urea + 1.5% $k_2HPO_4$ (treatment 6). The lowest yield weight (33.2 kgs/tree) was obtained from the control trees and the lowest yield as number of fruits (278 fruits/tree) was obtained by spraying urea alone.

From the abovementioned results, it could be concluded that the great increment in yield weight and number of fruits per tree obtained by NPK sprays may be explained by the improving effect of such treatments on nutrional status of the trees specially the relatively higher leaf K% obtained by these treatments which certainly reflected on increasing fruit weight, fruit set and finally yield of fruits/tree.

These results are in line with those reported by Shawky et al. (1970), El Deeb (1989), Ibraheim et al. (1993) and El-Fangary, (1998) who found that spraying urea and potassium dihydrogen phosphate or potassium from several forms enhanced fruit-set and increased yield of orange and mandarin trees.

**3. Fruit quality:**

***A. Physical Properties***

Data presented in Table (3) showed various fruit physical properties. It was clearly noticed that average fruit volume and diameter were increased significantly by different treatments when compared with those obtained from the control in both study seasons. The values ranged between (152-180 gm) and (180-213 gm) as weight, (165-190 $cm^3$) and (168-224 $cm^3$) as volume and (5.8-6.3 cm) and (6.3-7.2 cm) as diameter in the first and second season respectively.

Generally, increasing the concentration of either $KH_2PO_4$ or $K_2HPO_4$ from 1% to 1.5% in the spraying solution had no significant effect on average fruit weight, volume and diameter. Fruits taken from $K_2HPO_4$ foliar sprayed trees (treatments 5 and 6) tended to be of more weight than those of $KH_2PO_4$ sprays (treatments 3 and 4). Such results may be attributed due to the response of the trees to NPK foliar sprays. This means that the least values with respect to average fruit weight, volume and diameter were obtained by the control (treatment 1), since they recorded (110-142 gm), (120 – 156 $cm^2$) and (5.3-6.0 cm) in the first and second season respectively.

Concerning fruit juice weight and volume, the results indicated that their values followed the same trend obtained by different treatments on average fruit weight, volume and diameter and reached the maximum in treatment (6).

The present results are in agreement with the findings of Shawky et al. (1970) on Balady orange, El-Deeb (1989) on Washington navel and Valencia oranges and El-Fangary (1998) on Balady mandarin who found that spraying $KH_2PO_4$ with or without urea increased fruit weight, size, diameter and juice weight.

Fruit juice percentage was affected significantly by different treatments and a particular trend could be easily noticed that different treatments gave lower values in the first and second seasons compared with the control. Such results are almost same as those reported by Daveis and Albrigo (1994) who found that juice content was decreased as increasing potassium levels in the leaves from 0.3 to 1.9%.

Peel thickness was slightly affected by different treatments and no significant differences among treatments were obtained in both seasons. Although, in the second season all treatments tended to slightly increase peel thickness than the control. The values ranged between (0.43-0.48 m.m) and (0.47-0.50 m.m) in the first and second seasons respectively.

These results are in line with those reported by Shawky *et al.* (1970) who found that urea and potassium dihydrogen phosphate foliar sprays did not significantly affect rind thickness in Balady orange.

On the other hand, the obtained results are not in like with those obtained by El-Deeb (1989) on Washington navel, Valencia organs and El-Fangary (1998) on Balady mandarin who reported that $KH_2PO_4$ foliar sprays increased peel thickness.

***B. Chemical Properties***

The results in Table (4) revealed that the total soluble solids (T.S.S.), T.S.S./acid ratio and ascorbic acid (V.C) in fruit juice were significantly affected by different treatments in the first and second seasons while, fruit acidity was not affected.

In this respect, a general trend was noticed, that spraying trees with urea or urea combined with 1 or 1.5% $KH_2PO_4$ (treatments 2,3 and 4) did not affect T.S.S. or T.S.S/acid ratio when compared with the control in both seasons where their values were similar from the statistical stand point, their values ranged between (13.8-14.0%), (11.6-12.0%), (7.4-7.6) and (7.2-7.6) in the first and second season respectively. On the other hand, fruits taken from trees sprayed with 0.5% urea and dipotassium hydrogen phosphate specially at high concentration (1.5%) treatment (6) gave highest T.S.S and T.S.S/acid values, since it recorded (15, 12.6%) and (8.3, 8.4) in the first and second season respectively.

**Table (4): Effect of spraying NPK on fruit chemical properties of Hamlin orange trees during (1997 and 1998 seasons).**

| Treatments | TSS % | | Acidity % | | TSS/acid ratio | | Ascorbic acid mg/100 ml juice | |
|---|---|---|---|---|---|---|---|---|
| | 1997 | 1998 | 1997 | 1997 | 1998 | 1998 | 1997 | 1998 |
| 1) Control | 13.8 | 11.6 | 1.85 | 1.5 | 7.5 | 7.6 | 60 | 55 |
| 2) 0.5 % urea | 14.0 | 12.0 | 1.90 | 1.6 | 7.4 | 7.5 | 59 | 51 |
| 3) 0.5% urea + 1% $KH_2PO_4$ | 13.8 | 11.8 | 1.80 | 1.6 | 7.6 | 7.2 | 52 | 51 |
| 4) 0.5% Urea + 1.5% $KH_2PO_4$ | 13.8 | 11.9 | 1.83 | 1.7 | 7.5 | 7.2 | 51 | 50 |
| 5) 0.5% urea + 1% $K_2HPO_4$ | 14.8 | 12.5 | 1.80 | 1.6 | 8.2 | 8.0 | 52 | 48 |
| 6) 0.5% urea + 1.5% $K_2HPO_4$ | 15.0 | 12.6 | 1.80 | 1.5 | 8.3 | 8.4 | 48 | 46 |
| L.S.D. 5% | 0.9 | 0.6 | NS | NS | 0.5 | 0.5 | 5.0 | 3.8 |

Fruit acidity was not affected significantly by different treatments in the two seasons although, the values obtained in the second season tended to be lower than those of the first one. The values ranged between (1.8-1.9%) and (1.5-1.7%) in the first and second season respectively.

The obtained results are in agreement with those found by Shawky *et al.* (1970) and El-Deeb (1989) who found that foliar sprays with $KH_2PO_4$ with or without urea did not or slightly affected T.S.S., T.S.S/acid ratio and fruit juice acidity of Balady and Washington navel oranges.

Concerning ascorbic acid (V.C) content in fruit juice, results showed a particular trend in both seasons. The different treatments tended to decrease it significantly when compared with the control except, urea sprays in the first season, the decrease lacked significancy. This means that the highest values of ascorbic acid (V.C) in fruit juice were of the control. They recorded (60 and 55 mg/100 ml) in the first and second season respectively. Meanwhile, the values of (V.C) obtained by other treatments ranged between (48-59) in 1997 and (46-51) in 1998 seasons.

These results are in the same line reported by Koridez and Kuznetsov (1983) who found that K fertilization tended to decrease slightly vitamin C in Satsuma fruit juice.

However, Shawky *et al.* (1970) on Balady orange trees reported that urea and potassium dihydrogen phosphate sprays did not affect significantly V.C in fruit juice.

On the other hand, the obtained results are in contradiction with those of El-Deeb (1989) who noticed that $KH_2PO_4$ foliar sprays increased ascorbic acid content in fruit juice of Washington navel, Valencia organs and Balady mandarin.

From this investigation it could be concluded that mineral status, yield as well as fruit quality of Hamlin orange trees grown under Rafah conditions could be greatly enhanced by spraying trees with 0.5% urea +1.5% dipotassium hydrogen phosphate twice in late May and early August.

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## تأثير الرش ببعض العناصر الغذائية الكبرى على الحالة المعدنية والمحصول وجودة ثمار أشجار البرتقال الهاملن النامية تحت ظروف منطقة رفح .

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**قسم بحوث البساتين - المركز القومي للبحوث - ش التحرير - الدقي**

أجريت هذه التجربة على أشجار البرتقال الهاملن النامية بمزرعة رفح النموذجية بمحافظة شمال سيناء. وتضمنت التجربة الرش باليوريا بتركيز ٠,٥% منفردة أو مع صورتين من فوسفات البوتاسيوم وهما (فوسفات البوتاسيوم الأحادية، فوسفات البوتاسيوم الثنائية) بتركيز ١% أو ١,٥% لكل منهما وذلك مرتين: الأولى أواخر مايو والثانية أوائل أغسطس . وتهدف التجربة لدارسة تأثير الرش بتلك المواد على الحالة المعدنية بالأوراق والمحصول وجودة الثمار.

وقد أشارت النتائج إلى أن الرش باليوريا مع الصور المختلفة للبوتاسيوم قد رفع محتوى الأوراق من عناصر النيتروجين والفوسفور والبوتاسيوم وكذلك زيادة المحصول خاصة في حالة الرش مع فوسفات البوتاسيوم الثنائية بتركيز ١,٥%.

كما أدت معظم المعاملات إلى زيادة متوسط وزن وحجم وقطر الثمرة ووزن وحجم العصير والمواد الصلبة الذائبة الكلية وكذلك نسبة المواد الصلبة الذائبة الكلية إلى الحموضة. بينما انخفض محتوى العصير من حمض الإسكوربيك (فيتامين ج) وذلك عند المقارنة بالأشجار الغير معاملة في موسمي الدراسة. ولم تؤثر المعاملات على سمك القشرة والحموضة الكلية في العصير.

وعليه يعتبر رش أشجار البرتقال الهاملن باليوريا ٠,٥% + فوسفات البوتاسيوم الثنائية بتركيز ١,٥% مرتين من أنسب المعاملات تحت ظروف منطقة رفح بمحافظة شمال سيناء.

**Table (3): Effect of spraying NPK on fruit physical properties of Hamlin orange trees during (1997 and 1998 seasons).**

| Treatments | Fruit weight (gm) | | Fruit volume ($cm^3$) | | Fruit diameter (cm) | | Peel Thickness (m.m) | | Juice weight (gm) | | Juice Volume ($cm^3$) | | Juice % per fruit | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1997 | 1998 | 1997 | 1998 | 1997 | 1998 | 1997 | 1998 | 1997 | 1998 | 1997 | 1998 | 1997 | 1998 |
| 1) Control | 110 | 142 | 120 | 156 | 5.3 | 6.0 | 0.47 | 0.46 | 63.6 | 76.8 | 61.0 | 75.0 | 58.0 | 54.0 |
| 2) 0.5 % urea | 164 | 213 | 174 | 224 | 6.3 | 6.8 | 0.48 | 0.5 | 80.0 | 106.7 | 78.0 | 104.0 | 48.7 | 50.0 |
| 3) 0.5% urea + 1% $KH_2PO_4$ | 152 | 165 | 165 | 168 | 5.8 | 6.4 | 0.43 | 0.5 | 76.0 | 87.7 | 75.0 | 86.0 | 50.2 | 53.2 |
| 4) 0.5% urea + 1.5% $KH_2PO_4$ | 155 | 160 | 166 | 168 | 5.8 | 6.3 | 0.43 | 0.5 | 75.7 | 78.8 | 74.0 | 86.0 | 48.8 | 49.3 |
| 5) 0.5% urea + 1% $K_2HPO_4$ | 177 | 175 | 188 | 187 | 6.9 | 7.2 | 0.46 | 0.48 | 81.3 | 83.4 | 80.0 | 82.0 | 45.9 | 47.7 |
| 6) 0.5% urea + 1.5% $K_2HPO_4$ | 180 | 180 | 190 | 191 | 6.8 | 7.2 | 0.45 | 0.50 | 82.3 | 88.1 | 81.0 | 86.0 | 45.7 | 48.9 |
| L.S.D. 5% | 7.9 | 7.1 | 6 | 16.8 | 0.6 | 0.5 | NS | NS | 5.3 | 17.5 | 3.9 | 5.0 | 3.6 | 2.6 |