

**EFFECT OF FOLIAR APPLICATION WITH GA₃, KNO₃, UREA AND CaCl₂ ON
 YIELD AND QUALITY OF NAVEL ORANGE (*Citrus sinensis* L. OSBECK) FRUITS
 BY**

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ABSTRACT

This study was carried out during two successive seasons 2005 and 2006, Kafr El-Sheikh Governorate, Egypt to study the effect of some foliar applications (GA₃ 40 ppm, KNO₃ 5%, Urea 2% and CaCl₂ 2%) on fruit quality of Washington Navel orange fruits (*Citrus sinensis* L. Osbeck). The following characters were attended: Fruit drop %, fruit decay%, cracking weight(kg/tree), yield/tree and fruit characters as volume, weight, juice volume, peel thickness, SSC %, acidity %, SSC: acid ratio, vitamin C and leaf content of N, P, K, Ca and Mg. It was found that foliar spray has a pronounced effect on yield and fruit quality. Macro-nutrient elements such as N, P, K, Ca and Mg were increased by these treatments. Contrary most treatments significantly decreased ripening rate compared to control.

Key words: Orange, Fruit quality, GA₃, KNO₃ and CaCl₂.

INTRODUCTION

Egyptian climate is well-suited for orange production. Orange production accounts for well over half the total fruit production in Egypt. Orange cultivation is concentrated in two large geographic regions: the fertile Delta area and the newly reclaimed lands. Total orange production in 2003 also increased slightly over the 2002 level. The increase in orange production was mainly due to the increase in average yield, 21.6 MT/hectare in 2006/2007 compared to 21.5 MT/ hectare in 2005/2006. Navel oranges are the predominant variety, the main fruit available in Egypt during the winter. The Egyptian orange export season is relatively long, extending from December to April, and this is quite favorable for the export of Navel oranges. Egypt has excellent opportunities for expanding its orange exports due to its favorable climate and strategic geographic location, exports to the European market continue to be limited by the uneven quality of Egyptian oranges as well as by strong competition from other suppliers such as Spain,

Israel, and Morocco. Total Egyptian orange exports achieved 503,000 MT during the previous year(FAO, 2007).

Different plant growth regulators and other materials have improved yield and fruits quality under trial for a long time of citrus fruits. GA₃ has been known to reduce loss in weight and percentage of discarded fruits and retarded fruit color development during storage

KNO₃ has been known to increase the fruit set %, yield and fruit quality. Calcium application represents safe and effective method for extending the storage life of fresh fruit. Urea application may be useful in this aspect. The combination with Calcium or GA₃ increased N and Ca in the leaf El-Hammady *et al.*, 2000; Schafer *et al.*, 2000; Ali and Gobran 2002; Marzouk and Kasem 2002; Abd El-Rahman 2003; El-Otmami *et al.*, 2004a and Morsy and Abd El-Aal (2006)

This work aimed to increase of fancy Washington Navel orange fruits .
fruits available for export or local market of

MATERIALS AND METHODS

The present study was carried out during 2005 and 2006 seasons on Washington Navel orange (*Citrus sinensis* Osbeck) trees located in Kafr El-Sheikh Governorate, Egypt. The selected trees were about 40 years old, budded on sour orange rootstock and planted at 5 x 5 meter apart in a clay loamy soil with water table about 1.5 meter. Trees were selected to be uniform as possible in both vegetative growth and fruit load.

The experiment was designed according to the randomized block system, each treatment was comprised with three replicates, one tree per each replicate to receive one of the following treatments as shown as follow:-
1-GA₃ 40ppm (sprayed at 5March and 5 April)
2-KNO₃ 5% (sprayed at 5March and 5 April).
3-Urea 2% (sprayed at 5March and 5 April).
4-GA₃ 40ppm (sprayed at 5March and 5 April) + CaCl₂ 2% (sprayed at 1Oct., and 1 Nov.).
5-KNO₃ 5% (sprayed at 5March and 5 April) + CaCl₂ 2% (sprayed at 1Oct., and 1 Nov.).
6-Urea 2% (sprayed at 5March and 5 April) + CaCl₂ 2% (sprayed at 1Oct., and 1 Nov.).
7-Control (sprayed with water in two dates of treatments.

During the growing season for each year the following properties were carried out:
June and pre-harvest fruit drop:

In this respect the percentage of fruit drop was counted and the following equation was adopted.

$$\text{June drop \%} =$$

$$\frac{\text{Total No. of setted fruits} - \text{No. of fruits at late June}}{\text{Total No of flowers}}$$

x 100

Pre-harvest drop % =

$$\frac{\text{Total No. of final fruit set} - \text{total No. of mature fruits}}{\text{Total No of final fruit set}}$$

x 100

Fruit decay %:

Was calculated by the following equation =

$$\frac{\text{No. of decayed fruits}}{\text{Total No. of fruits}} \times 100$$

Fruit cracking: It was calculated as cracking

$$\text{rates: Cracking \%} = \frac{\text{No.of cracking fruits}}{\text{Total No.of fruits per tree}} \times 100$$

At harvest time (15 February), fruit samples of each replicate were picked separately for determining the following physical and chemical properties:-

Total yield of each tree as (kg /tree), fruit weight as (g); fruit shape; fruit volume was recorded by measuring the displaced water (cm³) and Juice volume (cm³).

Soluble solids content(SSC); titratable acidity; SSC/acid ratio and Vitamin-C of fruits were also determined as described by (A.O.A.C, 1990).

Leaf macro elements content (N, P, K, Ca and Mg) were determined according to Chapman and Pratt (1961) and Jackson (1967).

The obtained data were statistically analyzed according to Little and Hills (1972), means separations according to Duncan (1955).

RESULTS AND DISCUSION

Effect of foliar sprays of GA₃, KNO₃ and urea and its combination with CaCl₂ on:

I. Physical characters:

I.1. Fruit drop (%):

Data in (Table 1) show that fruit drop % gave highly significant variation in both seasons of study (2005 and 2006). The highest

values during first season was 13.2% and the lower one was 8.7% given by control and urea + CaCl₂ treatments, respectively. The same trend was showed during the second season, and values in this respect were 14.8% and 8.7% for control and urea + CaCl₂ treatments, respectively .

Table (1): Effect of foliar sprays with GA₃, KNO₃ and Urea and its combinations with CaCl₂ on fruit drop, fruit decay, cracking weight, yield, fruit weight and fruit volume of Washington Navel Orange during picking dates at 2005 and 2006 seasons.

Treatments	Fruit drop %		Decayed fruits %		Cracking weight (kg/tree)		Yield (kg/tree)		Fruit weight (g)		Fruit volume (cm ³)	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
GA ₃ 40ppm	11.7ab	12.7ab	1.4bc	1.4bc	5.1b	3.4b	90.1c	96.8c	205.5ab	213.1c	324.6	291.6bc
KNO ₃ 5%	12.5ab	13.3a	2.8a	1.5abc	0.6d	0.7d	120.6a	106.8bc	264.3a	272.0a	335.6	334.4ab
Urea 2%	10.9abc	11.1bc	2.7a	2.4a	2.2c	2.0c	100.1b	102.6bc	224.0b	237.4bc	329.0	302.5abc
GA ₃ + CaCl ₂ 2%	10.0bc	10.1cd	1.8bc	0.9c	7.6a	4.4a	95.5bc	97.0c	212.9b	228.7bc	289.6	285.8c
KNO ₃ + CaCl ₂ 2%	8.7c	9.5cd	1.7bc	0.7c	0.5d	0.6d	121.0a	119.8a	238.4ab	258.6ab	320.1	342.3a
Urea + CaCl ₂ 2%	8.7c	8.7d	2.2ab	1.0c	1.7c	2.6bc	99.6bc	96.3c	235.4ab	222.8c	319.0	298.0bc
Control	13.2a	14.8a	1.8bc	2.2ab	4.1b	3.3b	75.1d	75.6d	243.7ab	229.4bc	283.5	272.5c
F. test	**	**	**	*	**	**	**	**	*	**	NS	**

Means followed by a common letter in the same column do not differ significantly by Duncan's Multiple Range Test, 5% level.

1.2. Fruit decay (%):

Table (1) cleared that, the highest values in this respect were 2.8 and 2.4 % in both seasons by KNO₃ and urea treatments respectively, and lowest fruit decay percentage were obtained by GA₃ and KNO₃ + CaCl₂ treatments and recorded 1.4 and 0.7% in two seasons, respectively.

These data are in the same line with Mansour *et al.*, 1995; Ladaniy 1997; Schafer *et al.*, 2000, Marzuk and Kassem 2002 and Abd El-Rahman 2003.

1.3. Cracked fruits (kg/tree):

Data in Table (1) showed that the highest value 7.6 kg/tree was obtained by GA₃ + CaCl₂ treatment and lower value (0.5 kg/tree) was obtained by KNO₃ + CaCl₂ treatment. In the second season, data showed the same trend of the first season.

These data are in accordance with Intrigliolo *et al.*, 1991 and Sharma *et al.*, 2002b, they found that KNO₃ at 5% decreased splitting and cracking of fruits.

1.4. Yield (kg/tree):

Regarding to yield, data in Table (1) cleared that the variation among treatments were significantly during the two seasons. The highest yield was obtained by KNO₃ + CaCl₂ treatment in two seasons. Values were 121.0

and 119.8 kg/tree, respectively. While the lowest values (75.1 and 75.6 kg/tree) were obtained by control treatment in two seasons, respectively.

1.5. Fruit weight(g):

Data in Table (1), cleared that the highest fruit weight was 264.3 and 272.0 g and recorded by KNO₃ treatment, while the lowest fruit weight (205.5 g) was obtained by GA₃ treatment in two seasons, respectively.

The data are in line with those obtained by El-Shobaky and Mohamed 2000; Rathore *et al.*, 2001; Ali and Gobran 2002; Kassem and El-Sabroun 2002; Marzouk and Kassem 2002; Sharma *et al.*, 2002a; Abd El-Rahman (2003); El-Otmani *et al.*, 2004a and Morsy and Abd El-Aal 2006. On the other hand, El-Shafey *et al.*, 2002; El-Otmani *et al.*, 2002; Sharma *et al.*, 2002b found that, CaCl₂ or GA₃ sprays had no effect on total yield as kg/tree.

1.6. Fruit volume(cm³):

Fruit volume in Table (1), showed that no significant variations among treatments during the first season only, the highest value was 342.3 (cm³) obtained by KNO₃ + CaCl₂ treatment and lowest one (272.5 cm³) was obtained by control treatment in both seasons.

These results are in line with those obtained by Sharma *et al.*, 2002a; Ali and Gobran, 2002; Abd El-Rahman 2003 and El-Otmani *et al.*, 2004a and 2004b, they found that, spraying GA₃, urea, K⁺, KNO₃ and CaCl₂ increased fruit size. On the other hand, El-Hammady *et al.*, 2000 and Samman *et al.*, 2001a, found that, spraying CaCl₂ significantly reduced fruit volume.

1.7. Peel thickness(mm):

As for fruit peel thickness, data in Table (2), showed that the highest peel thickness (0.62mm) was recorded by KNO₃ + CaCl₂ treatment in first season and the lowest value (0.46mm) obtained by GA₃ + CaCl₂ treatment in both seasons.

These data are in line with El-Shobaky and Mohamed 2000; Samaan *et al.*, 2001; Marzouk and Kassem 2002 and Sharma *et al.*, 2002b, they reported that, peel thickness was increased by CaCl₂ at 0.5% and KNO₃ at 2% treatments. On the other hand, Rabeh *et al.*, 1994; El-Shafey *et al.*, 2002 and Kassem and El-Sabroun 2002, they found no effect on fruit peel thickness.

1.8. Fruit juice volume(cm³):

Data in Table(2), Showed that Urea 2% treatment gave the highest value in fruit juice volume (159.9 cm³) on the other hand GA₃ + CaCl₂ treatment recorded the lowest fruit juice volume (109.0 cm³) in second season. These data are agreement with El-Shobaky and Mohamed 2000; Samaan *et al.*, 2001; Abd El-Rahman 2003 and El-Otmani *et al.*, 2004b, they found that, spraying KNO₃, urea, CaCl₂ increased juice volume. On the other hand, Ghaly *et al.*, 1994 found that, spraying GA₃ at 10 ppm at full bloom or 20 ppm GA₃ pre-bloom, decreased juice volume on Washington Navel orange trees.

II. Chemical properties:

Data in Table (2) showed the effect of GA₃, KNO₃, urea, GA₃ + CaCl₂, KNO₃ + CaCl₂ and urea + CaCl₂ treatments on chemical properties of Washington Navel orange fruits during picking date.

II.1.SSC (%):

Data showed no significant variation among treatments during first season only. Data of SSC % ranged from 10.84 to 11.87% in first season and ranged from 11.33 to 13.93 % in second season, the highest SSC % was recorded by control treatment in second season. These data are in line with El-Hammady *et al.*, 2000 and Ritenour *et al.*, 2005, found that spray CaCl₂ or GA₃ reduced TSS content. While, El-Shafey *et al.*, (2002) and Harty *et al.*, 2004, reported that spraying CaCl₂ or GA₃ had no effect on TSS content.

Malik *et al.*, 2000; Samman *et al.*, 2001; Kassem and El-Sabroun 2002; Sharma 2002a; El-Shobaky and Mohamed 2000; Abd El-Rahman 2003; Kotsias 2004; Mudau *et al.*, 2005 and Morsy and Abd El-Aal 2006, they found that, spraying KNO₃ or urea or GA₃ and CaCl₂ increased TSS content.

II.2.Acidity (%):

Regarding to acidity %, data in Table (2) showed no significant variations among treatments in both seasons. Titratable acidity ranged from 1.74 to 1.84% in first season and from 1.84 to 1.92% in second season.

These data are agree with El-Shobaky and Mohamed 2000; Samman *et al.*, 2001; Marzouk and Kassem 2002; Sharma *et al.*, 2002b; Abd El-Rahman 2003; El-Otmani *et al.*, 2004b; Harty *et al.*, 2004; Mark *et al.*, (2005) and Ritenour *et al.*, 2005, they reported that, spraying GA₃ or CaCl₂ had no significant effect on titratable acidity. On the other hand, El-Hilali *et al.*, 2002; Kassem and E-Sabroun 2002; Sharma *et al.*, 2002a; Kotsias 2004; Morsy and Abd El-Aal 2006, they found that, spraying GA₃ or urea or KNO₃ or Ca⁺⁺ increased total acidity.

II.3.SSC:acid ratio:

Concerning to SSC/acid ratio, data in Table (2), showed that the highest value was 7.33 and recorded by control treatment in second season but lowest SSC: acid ratio (5.90) was recorded by KNO₃ + CaCl₂ treatment in second season. These data are accordance with, Ben Ismail *et al.*, 1995; Ladaniya 1997; El-Hammady *et al.*, 2000; El-Hilali *et*

al., 2002; El-Shafey et al., 2002 and Ritenour et al., 2005, they found that, spraying GA₃ or CaCl₂ had no significant effect on TSS/acid ratio. On the other hand, El-Shobaky and Mohamed 2000 and Morsy and Abd El-Aal 2006, they mentioned that spraying with K⁺ and Ca⁺⁺ gave the highest values on SSC/acid ratio.

II.4. Vitamin C (mg/100 ml juice):

As for Vitamin (C) content, data in Table (2) showed no significant variation among treatments during both seasons. Control treatment recorded the lowest values (49.7 and 47.8 mg/100 ml juice) in two seasons, respectively.

While the highest value (53.5 and 55.5 mg/100 ml juice) were recorded by GA₃ + CaCl₂ and KNO₃ + CaCl₂ treatments in both seasons, respectively. These data are in line with El-Hammady et al., 2000; Malik et al., 2000 and Samman et al., 2001, they found that, spraying urea or CaCl₂ or GA₃ had not significant effect on V.C. On the other hand, El-Shobaky and Mohamed 2000; Marzouk and Kassem 2002; Ali and Gobran 2002; El-Otmani et al., 2004b; Marzouk and Kassem 2002; Kotsias 2004 and Morsy and Abd El-Aal 2006, they found that, spraying GA₃, KNO₃, K⁺, CaCl₂ increased vitamin-C (L-ascorbic acid).

Table (2): Effect of foliar sprays with GA₃, KNO₃ and Urea and its combinations with CaCl₂ on fruit peel thickness, juice volume, SSC%, acidity %,SSC: acid ratio and vitamin C of Washington Navel Oranges during picking dates at 2005 and 2006 seasons.

Treatments	Fruit peel thickness (mm)		Juice volume / fruit (cm)		SSC (%)		Acidity (%)		SSC: acid ratio		Vitamin C (mg /100ml juice)	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
GA ₃ 40ppm	0.50cd	0.50cd	114.9c	126.7b	11.79	12.53c	1.78	1.86	6.62	6.74bc	51.3	51.8
KNO ₃ 5%	0.61a	0.59a	132.7bc	128.1b	10.84	12.33c	1.74	1.92	6.23	6.42c	53.2	53.0
Urea 2%	0.49cd	0.50cd	157.7a	159.9a	11.87	12.33c	1.76	1.90	6.74	6.49bc	52.1	51.1
GA ₃ + CaCl ₂ 2%	0.46d	0.46d	109.4c	109.4b	11.47	13.07b	1.80	1.90	6.37	6.88b	53.5	55.0
KNO ₃ + CaCl ₂ 2%	0.62a	0.58a	140.3ab	126.1b	11.44	11.33d	1.84	1.92	6.22	5.90d	52.4	55.5
Urea + CaCl ₂ 2%	0.55bc	0.55bc	129.4bc	134.4b	11.71	12.00c	1.76	1.92	6.65	6.25cd	52.1	52.1
Control	0.51cd	0.51cd	132.2bc	127.7b	11.60	13.93a	1.78	1.90	6.52	7.33a	49.7	47.8
F. test	**	**	**	*	NS	**	NS	NS	NS	**	NS	NS

Means followed by a common letter in the same column do not differ significantly by Duncan's Multiple Range Test, 5% level.

II. Some Macro-nutrient elements:

Data in Table (3) showed the effect of foliar sprays GA₃, KNO₃ and urea on N, P, K, Ca and Mg nutrient elements of Washington Navel orange trees during 2005 and 2006 seasons.

III.1. Nitrogen leaf content (%):

Regarding to nitrogen leaf content of Washington Navel orange as affected by GA₃, KNO₃ and urea treatments, data showed that nitrogen content showed a significant variation among treatments during the both seasons. The highest values (3.03% and 3.24%) were recorded by urea 2% treatment, while control treatment gave the lowest values

(2.29% and 2.01%) in two seasons, respectively.

III.2. Phosphorus leaf content (%):

As shown in Table (3), data cleared that phosphorus content showed a significant variation among treatments in the first seasons, only. During both seasons, the highest values of P (0.14%) was obtained by urea 2% whereas the lowest values were (0.10% was obtained by urea 2%.

III.3. Potassium leaf content (%):

Concerning K content as shown in Table (3) data revealed that, the highest values (0.85% and 0.84%) was obtained by KNO₃

5% treatment whereas the lowest values (0.52% and 0.47%) were recorded by control treatment in two seasons, respectively.

III.4. Ca and Mg (%):

As shown in Table (3) data cleared that during both seasons, the highest values of Ca% (4.37%) was obtained by control treatment in first season. Data in Table (3) showed that the highest value of Mg % was 0.35 % in

the first season by KNO₃ 5% treatment, while lowest value (0.20%) was recorded by control treatment in the same season.

These results are agreement with Kim *et al.*, 1996, El-Shobaky and Mohamed 2000; Ali and Gobran, 2002; El-Otmami *et al.*, 2002; Abd El-Rahman 2003 and El-Otmami *et al.*, 2004a.

Table (3): Effect of foliar sprays with GA₃, KNO₃ and Urea and its combinations with CaCl₂ on leaf macro elements content of Washington Navel Orange during 2005 and 2006 seasons.

Treatments	N %		P %		K %		Ca %		Mg %	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
GA ₃ 40ppm	2.68b	2.35c	0.13a	0.12	0.64b	0.62b	3.86b	4.03	0.31b	0.26
KNO ₃ 5%	2.68b	2.62b	0.11ab	0.13	0.85a	0.84a	3.86b	3.60	0.35a	0.26
Urea 2%	3.03a	3.24a	0.10b	0.14	0.62b	0.66b	4.33a	3.73	0.34ab	0.27
Control	2.29c	2.01	0.11ab	0.11	0.52c	0.47c	4.37a	4.11	0.20c	0.28
F. test	**	**	*	NS	**	**	*	NS	**	NS

Means followed by a common letter in the same column do not differ significantly by Duncan s Multiple Range Test, 5% level.

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تأثير الرش بالجبرلين و نترات البوتاسيوم واليوريا وكلوريد الكالسيوم علي المحصول وصفات الجودة لثمار البرتقال ابوسرة

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أجريت هذه الدراسة علي خلال موسمي ٢٠٠٥ & ٢٠٠٦ في محافظة كفر الشيخ وذلك بهدف دراسة تأثير الرش الجبرلين (٤٠ جزء في المليون) نترات البوتاسيوم ٥% واليوريا ٢% وكلوريد الكالسيوم ٢% علي المحصول وصفات الجودة لثمار البرتقال أبو سره. وكانت النتائج كالتالي:

- ١- أدي الرش خلال موسمي الدراسة الي الحصول علي اعلي محصول/ شجرة في المعاملة بنترات البوتاسيوم ٥% + كلوريد الكالسيوم ٢% في حين اعطي الكنترول اقل محصول للشجرة وذلك في خلال الموسمين.
- ٢- سجل الكنترول اعلي نسبة في تساقط الثمار و الثمار التالفة مقارنة بالمعاملة يوريا ٢% + كلوريد الكالسيوم ٢% التي سجلت اقل النسب في سقوط الثمار بين المعاملات بينما المعاملة بنترات البوتاسيوم ٥% + كلوريد الكالسيوم ٢% كانت اقل المعاملات في نسبة الثمار التالفة وقد سجلت المعاملة بالجبرلين (٤٠ جزء في المليون) + كلوريد الكالسيوم ٢% اعلي القيم في الثمار المشققة خلال موسمي الدراسة مقارنة بنترات البوتاسيوم ٥% + كلوريد الكالسيوم ٢% التي سجلت اقل القيم في نفس الصفة.
- ٣- اعلي قيمة لحجم الثمار نتجت عن المعاملة بنترات البوتاسيوم ٥% + كلوريد الكالسيوم ٢% بينما المعاملة بنترات البوتاسيوم سجلت اعلي وزن للثمار.
- ٤- أعطت المعاملة بنترات البوتاسيوم ٥% + كلوريد الكالسيوم ٢% اعلي القيم في سمك القشرة خلال موسمي الدراسة - أما عن اعلي حجم للعصير وجد في الثمار المعاملة باليوريا ٢% بينما الثمار من المعاملة بالجبرلين (٤٠ جزء في المليون) + كلوريد الكالسيوم ٢% - كانت اقل معنويا في حجم العصير.

- ٥- المواد الصلبة الذائبة أعطت قيما تتذبذب حول قيمة الكنترول خلال الموسم الأول اما في الموسم الثاني فقد أعطي الكنترول القيم الاعلى معنويا عن باقي المعاملات والقيم الأقل في هذا الصدد كانت المعاملة بنترات البوتاسيوم ٢% خلال الموسم الأول والمعاملة بنترات البوتاسيوم ٥% + كلوريد الكالسيوم ٢% في الموسم الثاني.
- ٦- أظهرت الحموضة اختلافات معنوية بين المعاملات وقد سجلت نترات البوتاسيوم ٥% + كلوريد الكالسيوم ٢% أقل القيم في حين ان المعاملة بنترات البوتاسيوم ٥% - نترات البوتاسيوم ٥% + كلوريد الكالسيوم ٢% - يوريا ٢% + كلوريد الكالسيوم ٢% في الموسم الثاني سجلت اعلى محتوى من الحموضة في الثمار وعلية فان نسبة السكريات: الحموضة كانت اعلى في الثمار الناتجة من المعاملة باليوريا ٢% والكنترول في الموسم الثاني.
- ٧- محتوى الثمار من فيتامين ج لكل المعاملات لم يظهر اختلافا معنويا خلال الموسمين وسجل الكنترول اعلى القيم خلال موسمي الدراسة.
- ٨- بدراسة بعض العناصر الغذائية الكبرى فقد اظهر النيتروجين اختلافات معنوية بين المعاملات والرث باليوريا ٢% كان الاعلى في حين أن الكنترول كان الأقل معنويا في محتوى النتروجين بينما الرث بالبوتاسيوم (نترات البوتاسيوم) أعطى اعلى قيمة في محتوى الأوراق من البوتاسيوم والأقل معنويا نتج عن الكنترول خلال موسمي الدراسة - الكالسيوم كان اعلى في الكنترول بينما القيم الأقل كانت ناتجة عن الرث بنترات البوتاسيوم ٥% في الموسمين. الفوسفور فقد تذبذب قيمة بين الارتفاع والانخفاض معنويا وغير معنويا خلال الموسم الأول والثاني علي الترتيب وكذلك الماغنيسيوم.