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EFFECT OF SLOW RELEASE NITROGEN FERTILIZERS ON LEAF MINREAL CONTENT, YIELD AND FRUIT QUALITY OF WASHINGTON NAVEL ORANGE TREES

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ABSTRACT

Washington navel orange trees grown in clay loam soil were fertilized with urea-formaldehyde (UF) as a slow release nitrogen fertilizer during two successive seasons 2002 and 2003 in a private orchard located in Banha, Kalubia governorate, Egypt.

Trees were fertilized with urea at 1000 gm N/tree divided into three equal doses as control treatment, while urea-formaldehyde was used at three doses 1000, 750 and 500 gm N/tree each of them added either as one application in March or divided into two equal applications added in March and June.

Results indicated that N, P and K contents in the leaves did not affect significantly by different treatments. In this respect, UF treatments enhanced nitrogen percentage comparing with urea treatment. So, UF at 1000 gm N/plant raised N content in the leaves comparing with the other treatments. On the other hand, fertilizing trees with UF at 500 gm N/tree either as one or two applications raised potassium content than the other treatments.

Concerning the effect on yield and fruit quality, the data reveal that all treatments had a significant effect on number of fruits per tree since; using UF at 500 gm N/tree significantly increased this parameter than the other treatments and gave the higher values especially when added as one application and resulted in highest yield weight/tree. On the other hand, no significant differences were detected between treatments on fruit weight, peel thickness, fruit juice content, total soluble solids, acidity and ascorbic acid in fruit juice, although the higher UF doses specially 1000 and 750 gm N/plant tended to increase peel thickness.

Thus, it seems that fertilizing Washington Navel orange trees with urea-formaldehyde at 500 gm N/tree as one application added in March is the suitable treatment under conditions of this study.

INTRODUCTION

Citrus is considered one of the first fruit crop in Egypt. It is well known that citrus needs large amounts of fertilizers especially nitrogen, since the recommended dose of nitrogen fertilizer in Egypt is about 1000 gm N/tree/year. In this respect, studies suggested that as much as 40-50% of the applied N is not available to the tree due to leaching, denitrification and volatilization (Davies & Albrigo, 1994).

The use of controlled-release sources of N fertilizer provides a continuous supply of N, consequently the N-use efficiency, reduce the N losses and reduce luxury consumption of nutrients (Koo, 1986 and 1988). Moreover, the use of such fertilizers led to reduce rates and number of applications during the growing season (Jackson & Davies, 1984), (Koo, 1988) and (Zekri & Koo, 1991).

Urea-formaldehyde (UF) is one of the slow release nitrogen fertilizers, which contain (38% N) 1.5% as urea N that provides an immediately available source. The residual N is derived from the biodegradation of cold-water-insoluble (fraction I) (typically about 28%), which rapidly mineralized. Hot-water-soluble (fraction II) is mineralized more slowly than fraction I. Hot-water-insoluble (fraction III) is mineralized at rate of about 10% per year, Janick (1979).

Therefore, the aim of this study is to investigate the effect of different doses and number of applications of urea-formaldehyde (UF) as a slow release N-fertilizer on leave mineral content, yield and fruit quality of Washington Navel orange trees grown in a private orchard located in Banha, Kalubia governorate, Egypt. So, now days we reduced the amount of nitrogen fertilization which used in the farm in order to reduced the amount of nitrate in the fruits.

MATERIALS AND METHODS

This study was carried out during two successive seasons 2002 and 2003 on Washington Navel orange trees grown in a private orchard located in Benha, Kalubia governorate, Egypt. Trees were 20 years old, budded on sour orange rootstock, planted at 6x6 meters on clay loam soil under basin irrigation system.

The various chemical analyses of the soil were determined by using the methods described by Cottenie *et. al.* (1982).

The results of soil analysis indicated that pH ranged between 7.85 and 8.10, E.C. between 2.22 and 2.65 dsm^{-1} and $CaCO_3$ ranged between 2.95 and 3.45%. The soil texture was clay loam.

Seven treatments of nitrogen fertilization were done as follows: -

1- 1000 gm N as urea divided into three equal doses in March, June and September (control).
2- 1000 gm N as urea-formaldehyde (UF) one dose added in March.
3- 1000 gm N as (UF) divided into two equal doses, added in March and June.
4- 750 gm N as (UF) one dose added in March.
5- 750 gm N as (UF) divided into two equal doses, added in March and June.
6- 500 gm N as (UF) one dose added in March.
7- 500 gm N as (UF) divided into two equal doses, added in March and June.

Each treatment was replicated three times on one tree/plot and the randomized complete block design was arranged.

All trees received yearly about 450 gm K_2O/tree as potassium sulphate (48-52% K_2O) divided into two equal doses (late March and mid August) and 150 gm P_2O_5 as calcium super phosphate (15.5% P_2O_5). The other agricultural practices were the same for all trees.

About forty leaves were taken in late August in each season from tagged non-fruiting and non-flushing spring growth cycle (Jones & Embleton, 1960) to determine N, P and K percentage in the leaves, which estimated by standard procedure according to Wild *et.al.* (1985).

In each season yield was harvested in late December. Number of fruits and yield weight in kg/tree were determined.

Samples of ten fruits from each tree were used to determine fruit weight, peel thickness, juice percentage, total soluble solids%, titratable acidity and ascorbic acid content using the methods described in (A.O.A.C., 1970).

The data were subjected to analysis of variance and Duncan's multiple range test was used to differentiate means (Duncan, 1955).

RESULTS AND DISCUSSION

Leaf mineral content:

Results in Table (1) show the effect of different doses and number of applications of urea-formaldehyde (UF) as slow release nitrogen fertilizer on leaf mineral content of Washington Navel orange trees. The data also reveal that all UF treatments raised N % in the leaves than the control (urea), but this increment lacked significance among the treatments. In this respect, fertilizing trees with 1000 gm N gave the highest values during the two studied seasons. However, N content in the leaves ranged between (2.27 – 2.39%) in the first season and (2.26 – 2.39%) in the second one.

Regarding phosphorus content, it is clear that the differences between treatments lacked significance in the two seasons of the study and there was no trend for such treatments on phosphorus content in the leaves. However, phosphorus % in the leaves ranged between (0.10 – 0.11%) and (0.11 – 0.12%) in the first and second season, respectively. Potassium content did not significantly affect by treatments. However, treated trees with UF at 500 gm N/tree either as one or two equal doses tended to increase potassium percentage than the other treatments including the control (urea).

The previous results could be explained according to Obreza & Rouse (1992), Alva *et. al.* (1993) and Alva & Paramasivam (1998) who reported that using slow release fertilizers increased nitrogen uptake efficiency and minimized nitrate leaching below the rooting depth in Cleopatra mandarin and Hamlin orange trees. El-Shazly & Abdel-Nasser (1994) worked on sour orange and found an increase in N and K values due to slow release nitrogen fertilizer treatment compared with the fast release N fertilizers. On the other hand, Hadas *et. al.* (1976) found no significant differences between UF at 500 and 1000 N/ha on P or K content in banana leaves. Shawky *et.al.* (1996 a) and (1996 b) found that UF treatments raised N and K contents in the leaves of banana than the traditional N fertilizer forms, they also found that UF at high dose enhanced N content than the low one.

Table (1): Nitrogen, phosphorus and potassium content in the leaves of Washington Navel orange trees as affected by urea-formaldehyde fertilizer in 2002 and 2003 seasons.

Treatments	N%		P%		K %	
	2002	2003	2002	2003	2002	2003
*Urea (1000 gm N)	2.27	2.26	0.10	0.11	0.93	0.91
**UF (1000 gm N) one dose	2.32	2.36	0.10	0.11	0.90	0.89
**UF (1000 gm N) two doses	2.39	2.39	0.10	0.12	0.90	0.91
**UF (750 gm N) one dose	2.30	2.36	0.11	0.12	0.97	0.98
**UF (750 gm N) two doses	2.33	2.35	0.10	0.12	0.98	0.98
**UF (500 gm N) one dose	2.30	2.31	0.11	0.11	1.06	1.03
**UF (500 gm N) two doses	2.31	2.33	0.10	0.12	1.10	1.08
Significance at 5% level	N.S	N.S	N.S	N.S	N.S	N.S

Means having the same letters within a column are not significantly different at 5% level.
* Urea. ** Urea-formaldehyde

Yield and fruit quality:

Data in Table (2) show the effect of urea-formaldehyde on yield as number of fruits on weight/tree and fruit weight of Washington Navel orange trees.

Number of fruits/tree was affected by various treatments, since using UF at 500 gm N/tree as one or two equal applications significantly increased final number of fruits/tree than the other treatments and gave the highest values in both seasons of the study. This increment could be due to reduce the number of fruit drop. On the other hand, fertilizing trees with 1000 gm N as UF either at one or two applications gave the lower number of fruits/tree. This was true in two studied seasons. The previous result could be explained due to the absence of mineral equilibration which consequently affected fruit drop or increase the foliage growth.

Regarding the effect on yield Kg/tree, it is noticed that treatments had a significant effect on this parameter, since all UF treatments raised yield weight/tree than urea except when trees fertilized with UF at 1000 gm N/tree either as one or two applications. In this respect, UF at 500 gm N/tree gave

the highest yield/ tree, especially when treated as one application since it recorded 89 and 110 kg/tree in the first and second season, respectively. As for fruit weight, the data presented showed that there was no significant effect on this value during the both seasons under the study.

Table (2): Number of fruits, yield weight/tree and fruit weight of Washington Navel orange trees as affected by urea-formaldehyde fertilizer in 2002 and 2003 seasons.

Treatments	No. fruits/tree		Yield wt./tree (kg)		Fruit wt. (gm)	
	2002	2003	2002	2003	2002	2003
*Urea (1000 gm N)	340 c	420 c	80 abc	93 ab	235	222
**UF (1000 gm N) one dose	319 d	386 d	73 bc	94 ab	230	243
**UF (1000 gm N) two doses	307 d	335 e	66 c	81 b	215	240
**UF (750 gm N) one dose	357 bc	377 d	82 ab	91 ab	230	243
**UF (750 gm N) two doses	363 b	387 d	83 ab	94 ab	230	242
**UF (500 gm N) one dose	398 a	477 a	89 a	110 a	222	232
**UF (500 gm N) two doses	383 a	450 b	88 a	111a	230	248
Significance at 5% level	S	S	S	S	N.S	N.S

Means having the same letters within a column are not significantly different at 5% level.
* Urea. ** Urea-formaldehyde

From the abovementioned results, it is clear that the increment in yield weight per tree was due to the increase in fruit numbers per trees. This result is agree with that obtained by Koo (1998) who reported that using different forms of slow release fertilizers produced more Valencia orange fruits than calcium nitrate and ammonium nitrate. He also added that the medium rate of slow release fertilizer produced more fruits than the higher and lower rates.

Results in Table (3) showed the effect of urea-formaldehyde either as doses or number of applications on fruit quality of Washington Navel orange trees. It is noticed that, there was no significant differences were detected for treatments on any of the fruit quality parameters (peel thickness, percentages of fruit juice, total soluble solids, acidity or ascorbic acid content in fruit juice). Thus, it is observed that the higher UF doses tended to increase peel

thickness specially 1000 and 750 gm N/plant. On the other hand, UF at 500 gm N/plant tended to increase the total soluble solids percentage in the juice. While as no clear trend was detected for treatments on juice, acidity or ascorbic acid contents. This was true in both seasons of the study.

Table (3): Peel thickness, juice%, total soluble solids, acidity and ascorbic acid content in the fruits of Washington Navel orange as affected by urea-formaldehyde fertilizer in 2002 and 2003 seasons.

Treatments	Peel thickness (cm)		Juice %		TSS %		Acidity %		Ascorbic acid (mg/100ml juice)	
	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
*Urea (1000 gm N)	0.47	0.42	43.3	43.6	11.2	11.4	0.80	0.79	48.0	49.2
**UF (1000 gm N) one dose	0.47	0.47	43.4	42.6	11.3	11.6	0.83	0.81	47.6	48.3
**UF (1000 gm N) two doses	0.51	0.46	42.2	42.6	11.2	11.5	0.87	0.85	48.1	49.1
**UF (750 gm N) one dose	0.51	0.46	42.8	43.2	11.8	12.0	0.82	0.83	47.9	48.8
**UF (750 gm N) two doses	0.50	0.45	43.5	43.4	11.6	12.1	0.80	0.89	47.8	48.9
**UF (500 gm N) one dose	0.48	0.44	43.3	42.9	11.8	12.0	0.82	0.85	48.2	48.9
**UF (500 gm N) two doses	0.48	0.43	42.6	42.9	12.0	12.2	0.84	0.83	48.4	49.0
Significance at 5% level	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

Means having the same letters within a column are not significantly different at 5% level.
*** Urea. ** Urea-formaldehyde**

The previous results are in agreement with those obtained by Obreza & Rouse (1992) who observed that the use of controlled-release nitrogen fertilizers improved yield and quality of Hamlin orange fruits compared with the water soluble N fertilizers. Zekri & Koo (1992) reported that fruit yield was the same in trees received slow release N fertilizers and those received the fast ones. In this respect, Akhundova (1966) as quoted by Koren'Kov (1983) on tea, who reported that urea-formaldehyde fertilizer had a big effect on the yield of tea. Moreover, Shawky *et.al.* (1996 a) & (1996 b) reported that no differences were detected between UF added as one or two applications on banana plants, also they found that UF at low concentration increased yield than the higher one or than the fast release forms of nitrogen fertilizers.

From the above results, it could be concluded that using urea-formaldehyde as a slow release nitrogen fertilizer are very useful especially when using at the lowest dose (500 gm N/tree). On the other hand, there

were no differences between numbers of application of UF. So, fertilizing Washington Navel orange trees with UF at 500 gm N/tree one dose added in March is the suitable treatment, since it enhanced nitrogen and potassium content in the leaves and significantly increased yield as weight and number of fruits/tree.

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تأثير الاسمدة النيتروجينية بطيئة الانطلاق على المحتوى المعدنى للاوراق والمحصول وصفات الجودة لثمار البرتقال بسرة

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اجريت هذه التجربة خلال عامى ٢٠٠٢ ، ٢٠٠٣ على اشجار البرتقال بسرة نامية فى ارض طينية طميية فى مزرعة خاصة تقع فى منطقة بنها بمحافظة القليوبية بمصر حيث تسميدها باستخدام اليوريافورمالدهيد كسماد نيتروجينى بطيئ الانطلاق خلال موسمين متتاليين.

تم تسميد الاشجار بما يعادل ١٠٠٠ جم ن/شجرة من كبريتات الامونيوم وذلك كأشجار مقارنة. بينما استخدم سماد اليوريا فورمالدهيد بما يعادل ١٠٠٠ & ٧٥٠ & ٥٠٠ جم ن/شجرة. وقد تم اضافة كل من هذه المعدلات مرة واحدة فى شهر مارس او على جرعتين متساويتين خلال اشهر مارس ويونيو.

اوضحت النتائج ان جميع المعاملات لم يكن لها تأثير معنوى على محتوى الاوراق من النيتروجين والفوسفور والبوتاسيوم. لكن لوحظ ان كل معاملات اليوريا فورمالدهيد قد حسنت من محتوى الاوراق من النيتروجين بالمقارنة بكبريتات الامونيوم. وقد وجد ان معدل١٠٠٠ جم ن/شجرة من اليوريافورمالدهيد قد اظهرت زيادة طفيفة فى محتوى الاوراق من النيتروجين مقارنة بباقى المعاملات. من ناحية اخرى ادى معدل ٥٠٠ جم ن/شجرة من سماد اليوريافورمالدهيد سواء اضيف مرة واحدة او مرتين الى زيادة محتوى الاوراق من البوتاسيوم بنسبه ملحوظة بالمقارنة بباقى المعاملات.

اما بالنسبه للمحصول وجودة الثمار فقد اظهرت المعاملات ان عدد الثمار/شجرة قد تأثر معنويا باستخدام اليوريافورمالدهيد بمعدل ٥٠٠ جم ن/شجرة حيث ادى الى زيادة معنوية فى عدد الثمار عن باقى المعاملات وقد اعطت هذة المعاملة اعلى قيمة خاصة عند اضافتها مرة واحدة، وقد تسببت هذه المعاملة فى الحصول على اقصى انتاجية للشجرة. اما بالنسبه للتأثير على صفات الثمار فانه لم يلاحظ اى اختلاف معنوى بين المعاملات على وزن الثمرة او سمك القشرة او محتوى الثمار من العصير او المواد الصلبة الذائبة الكلية وكذلك حامض الاسكوربيك على الرغم من ان التركيزات المرتفعة من اليوريافورمالدهيد وخاصة ١٠٠٠ ، ٧٥٠ جم ن/نبات قد ادت الى زيادة ملحوظة فى سمك القشرة. من ناحية اخرى فقد ادى تركيز ٥٠٠ جم ن/نبات الى زيادة ملحوظة فى نسبه المواد الصلبة الذائبة الكلية بالعصير.

وهكذا يبدو ان تسميد اشجار البرتقال بسرة باليوريافورمالدهيد بمعدل ٥٠٠ جم ن/شجرة مضافه مرة واحدة فى شهر مارس تعتبر انسب المعاملات تحت ظروف هذه التجربة. ويوصى باجرائها لتقليل استخدام الاسمدة النيتروجينية مما يقلل من تراكمها فى الثمار خاصة وان البرتقال بسرة من الثمار ذات القيمة التصديرية العالية للاسواق الاوروبية.