Response of "Anna" Apple Trees to Soil and Foliar Nitrogen Fertilization

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ABSTRACT

The effect of nitrogen fertilization either as a soil application, in the form of ammonium sulphate at the rates of 0.5, 1.0 and 1.5 kg N/tree or as a foliar application of 0.5, 1.0 and 1.5% in the form of urea on vegetative growth, leaf and spur mineral contents, yield and chemical properties of "Anna" apple trees was studied through two field traits conducted in 2004 and 2005 seasons. The obtained results revealed that, nitrogen fertilization as a soil application or foliar sprays, generally, tended to increase shoot length, No. of leaves/shoot and average leaf area/ leaf in both years. Moreover, N fertilizer treatments either soil or foliar increased leaf and spur N concentration compared with unfertilized control. All treatments show that leaf and spur N concentrations were below the recommended range of 2.2 to 2.4% for comparable apple cultivars. Results of leaf analysis indicated that nitrogen soil or foliar application, with higher rates tended to decrease leaf P, Fe and Zn, while increased leaf K, Mg and Mn contents against to control in both experimental seasons. Data also, showed that N fertilization either soil application or foliar sprays gave greater yield and fruit weight especially in the second season compared with N – nil – control. Fruit firmness was reduced, generally, from 0.5 to 1.0 lb by all N treatments relative to controls but did not different significantly among foliar urea sprays in one hand, and among soil ammonium sulphate, in the other in both years. Furthermore, red color intensity determined as anthocyanin dye was reduced with all N treatments and inconsistent from year to year. Total soluble solids, as well as, total sugar and titratable acidity differed in both years and gave inconsistent results. At the same time, N fertilization treatments increased starch percentage at harvest time as compared with nil-N-control in both years.

INTRODUCTION

"Anna" apple is a good cultivar and has medium sugar, acid contented and poor storage qualities (Crosby *et at.*, 1994). However, production of "Anna" has been limited by its tendency to produce small fruit even with chemical thinning and irrigation. Therefore, in adequate fruit size and poor storability could impede acceptance of "Anna" by growers and processors. Fruit size in apple is determined by the interaction of varietal genetic traits, environmental conditions and cultural practices in the orchard. Nitrogen fertilization is a common practice to increase fruit size and yield, and maintain adequate tree vigor (Stiles and Reid, 1991). However, the effects of N fertilization are variable and some studies have shown little or no fruit size response to increasing rates of N fertilization (Goode and Higgs, 1977; Hipps *et al.*, 1990; and Neilsen *et at.*, 1999). Furthermore, fruit size and yield increases in response to N fertilizers are

sometimes off set by undesirable impacts on fruit color and quality (Fallahi *et al.*, 1997 and Raese and Drake, 1997). If tree N reserves are already adequate, then fertilizer applications may be counter- productive. When tree N demand exceeds soil N availability trees will usually respond in growth and yield to applied N fertilizer. However, when soil N availability exceeds tree N demand, trees are often unresponsive to applied N, crop uptake of N fertilizer decreases, and the N leaching potential increases (Weinbaum *et al.*, 1992).

Nitrogen is essential element most commonly applied in apple orchards without any correlation between source; amount of N applied and tree productivity. N nutrition increased protein synthesis and photosynthetic capacity (Haynes and Goh, 1978, Marin and Escobar, 1997 and Stiles and Reid, 1991).This study was conducted to determine if N fertilizer treatments applied in soil or foliar would increase vegetative growth, fruit size, quality and quantity of "Anna" apple and to evaluate different rates, times and methods of N fertilization for this apple variety.

MATERIALS AND METHODS

The present study was conducted through the three successive seasons 2003, 2004 and 2005 on ten years old," Anna "apple trees grown in Al- Nubaria region, El-Behira governorate. All trees were grafted on Malling Merton 106 rootstock. The trees were spaced 4×5 m apart, and received the same agro – managements. Thirty-five healthy apple trees nearly uniform as possible in growth vigor and productivity were chosen for this study. Soil samples were, randomly, taken from the two depths (0-30 cm and 30-60 cm) prior to initiating and termination of experiments and analyzed for physical and chemical properties **(Table 1)**. Soil structure of experimental site was sandy – calcareous and generally poor in most mineral nutrients, especially nitrogen. The trees were subjected under flooding irrigation system. The irrigation water analysis was PH 7.35, EC 2.3 (ds/m), Ca^{++}4.2meq/L, Mg^{++}2.9 meq/L, Na^{+}15.3 meq/L and K^{+}0.6 1meq/L. Soil and water samples were analyzed according to Jackson (1973).

Seven nitrogen fertilization treatments were arranged in a randomized complete block design and each treatment was replicated five times. Each replicate consisted of an individuel tree. The nitrogen fertilizer were supplied as a soil application at rates 0.5, 1.0 and 1.5 Kg N/tree as ammonium sulphate, $(NH_4)_2SO_4$, 20% N (Half of dose was applied in mid – February, while the remaining N was applied in mid – April) or supplied as a foliar application at concentrations 0.5, 1.0 and 1.5 % urea, 46% N ($N_2H_4CO_2$) containing 0.1% Tween 20 as a surfactant agent, sprayed

until run – off to whole trees at early – March and early - May as well as the control treatment in both experimental seasons, 2004 and 2005. Furthermore, in 2003 season, the trees under study were treated with the same N treatments for more establishment of the trees (data are not shown).

As for vegetative growth parameters, twenty-five shoots in the central part of the canopy of each tree were labeled, shoot length, number of leaves /shoot and leaf area / leaf were determined at late of May when growth was ceased. Leaf samples were collected 60 to 70 days after petal - fall for determination of foliage nutrient concentrations. Twenty- five leaves on each experimental tree were collected from the mid portion of current season shoots, composted and dried to constant weight in paper bags at 80 C°. Nitrogen concentrations were determined by a micro- Kjeldahl procedure (Greweling, 1976). Other macro-and micro nutrients were extracted from dry ashed samples in ammonium acetate and concentration were determined by spectrophotometer atomic absorption (model 975 Atom comp) as described by (Greweling and Peech, 1965). In March 2004 and 2005, 10 spurs about 2.5 cm (1 inch) in length with flower buds attached were collected from the periphery of each tree. The samples were composted and oven dried to constant weight in paper bags at 80C° and then analyzed for N using a micro – Kjeldahl procedure.

In both experimental seasons, number of flowers/cluster and fruit set were assessed by selecting two branches about 2.5 cm in diameter on each tree , counting bloom clusters during full bloom (Agnello *et al.*, 1999).

When fruit drop was finished in late May, the percentage of flowers that set was estimated on the same limbs by counting the remaining fruits.

Fruits were harvested on 17 and 25 June in 2004 and 2005 seasons, respectively. All fruits on each tree were weighed, and average fruit weight was determined. Ten fruits sub sample was assessed for maturity, selecting fruit within ±5% of the mean fruit weight for each replicate tree. Anthocyanin was determined (mg /100g fresh weight) according to Rabion *et al.* (1977).

Firmness was measured on opposite sides of each fruit using EPT-I pressure tester fitted with an 11.1 mm (0.43 inch). The juice resulting from these punctures was combined and assessed for soluble solids concentration with a refractometer. Acidity was measured on juice extracted from a blended composite with a titration against 0.1 NaOH and phenol phthalene as indicator (A.O.A.C, 1980). The starch was determined in 0.1 gm of the residue by hydrolysis with concentrated Hcl for 3 hours under reflex condenser (A.O.A.C., 1980).

Total sugar (%) was determined calorimetrically using phenol sulphuric acid according to Malik and Singh (1980).
Data were subjected to analysis of variance using the state view 5.0 statistical packages (SAS Inc.), comparison of means was conducted using L.S.D at 0.05% probability according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

Vegetative growth:

Nitrogen fertilization on apple trees "Anna" cultivar as a soil application with ammonium sulphate or foliar application with urea, generally, tended to increase slightly mean shoot length, No. of leaves/ shoot and leaf area in both experimental seasons **(Table 2)**. As for shoot length, data showed that soil application of ammonium sulphate at the rates of 0.5, 1.0 and 1.5 Kg N/tree gave slight increase in shoot length over than the control and the differences were not significant in both seasons. Also, foliar application with urea at the concentrations of 1.0% and 1.5% significantly increased shoot length relative to control treatment in both seasons. Similar results were obtained by Williams (1965) and Wargo *et al.* (2003).

Concerning the effects of soil or foliar application on number of leaves/ shoot, data in **Table (2)** revealed that number of leaves/ shoot increased significantly as increased soil or foliar concentrations compared with the control treatment in the second season, while in the first season no significant differences were found among all N fertilization treatments and control. The average leaf area was generally higher when nitrogen was applied to soil or foliar compared with untreated trees in both seasons with no significant differences. The same trend was obvious by Fisher and Cook (1950), Goode and Higgs (1977), Fallahi *et al.* (1997), and Neilsen *et al.* (1999).

Nitrogen status and fruit set:

All N fertilizer treatments soil or foliar generally increased leaf N concentrations compared with control in 2004 and 2005 seasons **(Table 3)**. However, foliar application of urea significantly increased leaf N content in both seasons, while soil application of ammonium sulphate also increased the leaf N content but insignificantly as compared with untreated trees in both years. Leaf N concentrations for all treatments were below the recommended range of 2.2 to 2.4 % for comparable apple varieties (Stiles and Reid, 1991).

This observation suggests that a substantial portion of N uptake occurs outside root – zone (Wargo *et al.*, 2003).

Also, the data in **Table (3)** showed that N fertilizer treatments either soil or foliar increased spur N concentration compared with unfertilized control. Foliar urea sprays increased spur N compared with control and soil application of ammonium sulphate. Several studies have also shown that, soil N applications and urea sprays increased reserve N content in dormant buds of pome fruits (Oland, 1960; Williams, 1965., Sanchez *et al.*, 1992 and Khemira *et al.*, 1998).

N fertilizers either foliar or soil application did not enhance number of flowers/cluster compared with the control in both seasons, but data showed that trees treated with urea foliar application had greater number of flowers/ cluster than trees treated with either soil N application or control treatments. This foliar fertilization appeared to be an important factor in increasing flowers in both seasons (**Table 3**).The same trend was observed with fruit set percentages. It was found improving in fruit set with increasing N concentrations. Also, foliar urea sprays increased fruit set than soil N application and control treatment in both years. Improved bloom density and fruit set as subsequent of N fertilization was also reported by Williams (1965), who speculated that previous late summer N supply increased the effective pollination period during the next year's bloom. Unlike previous reports, foliar urea applications did not increase bloom density or fruit set in apple trees (Oland, 1960; Sanchez *et al.*, 1992 and Khemira *et al.*, 1998).

Leaf mineral composition:

The effects of soil and foliar N applications at various rates in the form of ammonium sulphate and urea on leaf mineral composition of "Anna" apple trees during 2004 and 2005 seasons are illustrated in **Table (4)**. Results of leaf analysis indicated that nitrogen soil application with altars or foliar spray, with high rates, tended to decrease leaf phosphorus concentration in both seasons. Moreover, all soil N application and foliar sprays of urea at the concentrations of 1.0 1.5 % in the second season, significantly decreased leaf P content compared with control treatment. At the meantime, no significant differences were found among all other N treatments compared with untreated trees **(Table 4)**. This may be due to the antagonistic effect between N and P (Neilsen *et al.*, 1984; Stiles and Reid, 1991; Raese and Drake, 1997, and Wargo *et al.*, 2003).

As for leaf K content data revealed that increasing soil application or foliar of nitrogen corresponded with increasing leaf K concentration in both seasons **(Table 4)**. Data also showed that all N treatments significantly increased leaf K content as compared with untreated trees in the second year. These surprisingly leaf K concentrations in apple trees enhanced by

the addition of N fertilizer linked with the findings of Hansen, 1980, Crosby *et al.*, 1994 and Agnello *et al.*, 1999).

Concerning leaf Mg content, data showed that increasing soil or foliar nitrogen application, gradually, increased Mg concentration in both seasons. Also, it was noticed that leaf Mg concentration increased when N was applied as urea foliar application rather than with N applied as ammonium sulphate in both years. At the same time, no significant differences were found in leaf Mg concentrations among soil N application in one hand, and among foliar N application, on the other.

The effects of soil and foliar N fertilization on leaf Fe, Zn and Mn are presented **Table (4)**. Soil and foliar application of N as ammonium sulphate and urea, generally, attained to reduce leaf Fe and Zn content against control in both years. On the other hand, soil and foliar application of N significantly increased leaf Mn content in both experimental seasons. The same results were found by Hipps *et al.* (1990) and Blanpied and Silsby (1992).

Yield components:

Yield as Kg/ tree and average fruit weight as affected to N fertilization either foliar sprays with urea or soil application with ammonium sulphate were illustrated in **Table (5)**. Total yield and fruit weight in both seasons were greater in all N Treatments compared with control. Higher yields were obtained with foliar or soil application of nitrogen compared with untreated trees. Also, data showed that foliar urea increased average weight of fruit compared with soil applied ammonium sulphate in both years. In a similar study with a Gala apple variety, Neilsen *et al.* (1999) reported that yields were relatively insensitive to different rates and timing of soil N application, with no yield differences during 4 years of single N application of 80 Kg/ha. Results of the present study, on the other hand are confirmed with data reported by Wargo *et al.* (2003).They reported that, foliar urea sprays increased yield and crop load of 'Gold Rush.' more than the customary late spring soil N applications, even though relatively less N was applied in the foliar treatments. In a comparable study, Fisher and Cook (1950) also found that foliar urea sprays increased fruit set and yield compared to similar amounts of N applied to soil beneath trees. These observations indicate that foliar urea sprays may increase yield more efficiently than soil N applications.

Fruit firmness and internal quality:

Influence of different rates of ammonium sulphate and various concentrations of urea as soil and foliar application, on fruit firmness and some internal chemical quality parameters, is presented in **Tables (6) and (7)**. Fruit firmness was reduced, generally, from 0.5 to 1.0 lb by all N treatments relative to control but did not differ significantly among foliar urea sprays on one hand, and among soil ammonium sulphate application, on the other in both years. The same results were found by Neilsen *et al.* (1984), Kassem (1991), and Wargo *et al.* (2003). It was found, by the latter investigators, that no differences in firmness of 'Golden Delicious' apple occurred over a range of N fertilization from 30 to 180 Kg/ha.

Fully mature "Anna" apple fruit have a yellow back ground color with medium blushed redish overtones, and all of the studied N treatments reduced the percentage of red color intensity determined as anthocyanin dye. However, red color intensity among N treatments were inconsistent from year to year, but in general tended to reduce blushed surface area and red color intensity measured as anthocyanin percentages. It was noticed that, back ground color was greener (less anthocyanin) on fruits of all N fertilized trees as evidenced by anthocyanin percentages in both years **(Tables 6 to 7)**. Moreover, data revealed that, trees receiving foliar urea have greener than (less anthocyanin %) fruits of trees receiving soil ammonium sulphate fertilizer applications. In general, yellow back ground color of fruits decreased in all N fertilized trees relative to control, but did not differ significantly among foliar urea sprays on one hand, and among soil fertilizers, on the other in both years. The same results were found by Neilsen *et al.* (1984) and Wargo *et al.* (2003).They all found that high N supply delayed chlorophyll breakdown and reduced yellow apples. On the contrary, Hansen (1980) reported that soil N application in late spring or early summer reduced yellow coloration relative to early spring N treatments.

Total soluble solids in fruits were above 11% in all N treatments in both years, and were higher in control than fertilized trees in the second season **(Tables 6 to 7)**. Fruits from the foliar urea sprays generally had lower soluble solids compared to soil ammonium sulphate applications in both years. The same trend was found for total sugar percentages with no significant differences. Similar results were also reported by Fallahi *et al.* (1985) and Wargo *et al.* (2003). Also, N fertilizer did not affect the titratable acidity of fruits. Fruit maturity at harvest, as determined by starch percentages, was significantly affected by N treatments. Increasing N fertilizers either soil or foliar application, generally, increased starch percent as compared with nil-N- control in both seasons. The same trend was confirmed by Neilsen *et al.* (1984) and Wargo *et al.* (2003).

Table (1): Physical and chemical analysis of soil samples at the start and the end of experiment (average of two seasons).

Depths (cm)	Sand %	Silt %	Clay %	PH	OM %	EC (ds\m)	Anions(meq/l)			Cations(meq/l)			Na^+	K^+
							HCO_3^-	Cl^-	SO_4	NH_4^+	Ca^{++}	Mg^{++}		
Before experiment														
0 – 30	71.2	18.3	10.5	7.31	0.12	2.31	1.17	25.3	11.8	0.051	13.2	11.1	31.2	0.91
30 – 60	72.3	19.2	8.5	7.51	0.13	2.62	1.29	13.2	6.9	0.061	16.3	9.3	29.2	0.89
After experiment														
0 – 30	74.2	17.3	8.5	7.38	0.17	2.32	1.21	26.2	11.9	0.062	17.2	11.3	39.3	0.97
30 – 60	75.3	16.9	7.8	7.62	0.16	2.52	1.31	27.3	7.3	0.071	16.3	10.3	41.2	0.91

Table (2): Nitrogen fertilization effects on shoot length, number of leaves / shoot and leaf area of "Anna" apple trees in 2004 and 2005 seasons.

N Treatments	Shoot length(cm)	Number of leaves/shoot	Leaf area(cm^2)	Shoot length(cm)	Number of leaves/shoot	Leaf area(cm^2)
Foliar application		2005			2005	
0.5 % Urea	25.1 bc	21.9 a	39.2 a	20.1ab	20.2 b	39.2 a
1.0 % Urea	27.0.3b	22.1 a	39.2 a	21.9a	22.8 a	39.8 a
1.5 % Urea	35.1 a	23.3 a	38.3 a	22.3a	23.6 a	39.2 a
Soil application						
0.5Kg N/tree	21.9 c	20.9 a	38.2 a	19.2 ab	22.9 a	38.1 a
1.0Kg N/tree	22.9 c	20.9 a	39.3 a	19.1 ab	23.3 a	38.9 a
1.5Kg N/tree	23.2 c	22.2 a	39.2 a	19.3 ab	24.6 a	38.3 a
Control	22.3 c	20.1 a	38.2 a	17.0.3b	18.3 b	37.2 a

The same letter(s) within the same column are not significant using L.S.D. at 0.05.

Table (3): Nitrogen fertilization effects on leaf and spur N concentration, number of flowers/ cluster and fruit set percentage of "Anna" apple trees in 2004 and 2005 seasons.

N Treatments	Leaf N (%)		Spur N (%)		Number of flowers/cluster		Fruit set (%)	
	2004	2005	2004	2005	2004	2005	2004	2005
Foliar application								
0.5 % Urea	2.11 a	2.15 a	1.72 a	1.76 a	14 ab	13 ab	17.2 ab	22.3 ab
1.0 % Urea	2.13 a	2.15 a	1.79 a	1.81 a	14 ab	15 ab	18.3 ab	23.2 ab
1.5 % Urea	2.13 a	2.16 a	1.82 a	1.82 a	17 a	16 a	19.2 a	25.3 a
Soil application								
0.5Kg N/tree	1.98 ab	2.01 ab	1.63 ab	1.71 ab	11 b	12 b	16.9 ab	20.1 ab
1.0Kg N/tree	1.98 ab	2.01 ab	1.69 ab	1.78 a	13 ab	12 b	16.2 ab	20.3 ab
1.5Kg N/tree	2.02 ab	1.99 ab	1.72 a	1.81 a	11 ab	12 b	16.2 ab	21.3 ab
Control	1.78 b	1.79 b	1.51 b	1.62 b	10 b	12 b	13.1 b	17.3 b

The same letter(s) within the same column are not significant using L.S.D. at 0.05.

Table (4): Nitrogen Fertilization effects on some macro and micro-nutrients of "Anna" apple leaves in 2004 and 2005 seasons.

N Treatments	P	K	Mg	Fe	Zn	Mn	P	K	Mg	Fe	Zn	Mn
		(%)			(ppm)			(%)			(ppm)	
Foliar application												
0.5 % Urea	0.19a	1.21ab	0.55a	260a	45a	36a	0.18ab	1.11b	0.51ab	260a	41cb	37a
1.0 % Urea	0.18ab	1.31a	0.56a	259a	46a	37a	0.17b	1.21ab	0.53ab	253ab	43cb	39a
1.5 % Urea	0.17b	1.31a	0.56a	251ab	46a	38a	0.17b	1.25a	0.54a	243cb	47ab	40a
Soil application												
0.5Kg N/tree	0.17 b	1.02 b	0.51 ab	259 a	45 a	38 a	0.17 b	1.21 ab	0.50 ab	245c b	44 ab	36 a
1.0Kg N/tree	0.16 b	1.11 b	0.55 a	251 ab	45 a	39 a	0.17 b	1.28 a	0.49 ab	240c d	39 cd	38 a
1.5Kg N/tree	0.16 b	1.14 ab	0.55 a	245 ab	39 b	41 a	0.17 b	1.29 a	0.52 ab	231 d	37 d	39 a
Control	0.19 b	0.81 cb	0.41 b	276 b	46 a	23 b	0.19 a	0.88 c	0.41 b	262 a	48 a	28 b

The same letter(s) within the same column are not significant using L.S.D. at 0.05.

Table (5): Nitrogen fertilization effects on yield Kg/ tree and fruit weight of "Anna" apple trees in 2004 and 2005 seasons.

N Treatments	Yield Kg/Tree	Fruit weight (g)	Yield Kg/Tree	Fruit weight (g)
	2004		2005	
Foliar application				
0.5 % Urea	35.3 a	115 b	36.8 ab	125 ac
1.0 % Urea	36.2 a	117 a	38.2 a	127 a
1.5 % Urea	38.3 a	119 a	43.3 a	127 a
Soil application				
0.5Kg N/tree	33.2 a	114 b	35.2 ab	121 bc
1.0Kg N/tree	33.9 a	115 b	37.3 a	123 ac
1.5Kg N/tree	35.3 a	116 ab	38.9 a	124 ac
Control	27.2 b	110 c	28.6 b	118 b

The same letter(s) within the same column are not significant using L.S.D. at 0.05.

Table (6): Nitrogen Fertilization effects on firmness and some chemical properties of "Anna" apple fruits in 2004 season.

N Treatments	Firmness ($lb/inch^2$)	Anthocyanin (mg/100g)	T.S.S* (%)	T.A** (%)	Starch	Total sugar (%)
Foliar application						
0.5 % Urea	13.8 a	16.8 ab	11.4 c	0.672 a	3.3 bc	7.5 a
1.0 % Urea	13.7 a	14.3 b	11.5 bc	0.658 a	3.5 ab	7.2 a
1.5 % Urea	13.5 a	13.8 b	11.7 a	0.697 a	3.5 ab	7.5 a
Soil application						
0.5Kg N/tree	13.9 a	16.3 ab	11.8 a	0.682 a	3.4 abc	8.2 a
1.0Kg N/tree	13.7 a	15.2 ab	11.7 a	0.694 a	3.4 abc	7.7 a
1.5Kg N/tree	13.7 a	14.7 b	11.7 a	0.692 a	3.6 a	7.6 a
Control	14.1 a	17.9 a	11.8 a	0.683 a	3.2 c	7.4 a

The same letter(s) within the same column are not significant using L.S.D. at 0.05. *T.S.S: Total Soluble Solids * *T.A: Titrable Acidity

Table (7): Nitrogen fertilization effects on firmness and some chemical properties of "Anna" apple fruits in 2005 season.

N Treatments	Firmness ($lb/inch^2$)	Anthocyanin (mg/100g)	T.S.S* (%)	T.A** (%)	Starch (%)	Total sugar (%)
Foliar application						
0.5 % Urea	11.8 ab	15.1 abc	11.5 c	0.672 a	3.6 ab	7.7 a
1.0 % Urea	11.5 ab	13.8 abc	11.7 b	0.679 a	3.6 ab	7.2 a
1.5 % Urea	11.3 b	12.1 c	11.6 cb	0.681 a	3.7 a	7.9 a
Soil application						
0.5Kg N/tree	11.5 ab	15.3 ab	11.7 b	0.672 a	3.5 ab	8.2 a
1.0Kg N/tree	12.3 a	14.8 abc	11.7 b	0.673 a	3.5 ab	7.7 a
1.5Kg N/tree	12.1 ab	13.2 bc	11.8 a	0.683 a	3.4 b	7.2 a
Control	12.3 a	16.3 a	11.9 a	0.672 a	3.1 c	8.3 a

The same letter(s) within the same column are not significant using L.S.D. at 0.05. *(T.S.S: Total Soluble Solids * *T.A: Titrable Acidity

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الملخص العربي

استجابة أشجار التفاح صنف " الأنا " للتسميد النيتروجيني الأرضي والرش

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تم دراسة تأثير التسميد النتروجين أما أرضيا بمعدلات ٠,٥ , ١ , ١,٥كجم نيتروجين / شجرة في صورة سلفات أمونيوم أو إضافته رشاً على الأوراق في صورة يوريا بتركيزات ٠,٥، ١,٠ و١,٥% على كل من النمو الخضري ومحتوى الأوراق والبراعم من العناصر المعدنية , المحصول والمحتوى الكمياوى للثمار وذلك في أشجار التفاح صنف " آنا"خلال موسمي الدراسة ٢٠٠٤،٢٠٠٥ وقد أشارت النتائج المتحصل عليها أن التسميد النيتروجيني سواء أرضياً أو رشاً على الأوراق أدى إلى زيادة في طول النموات الخضريه وعدد الأوراق ومتوسط مساحة الورقة في كلا موسمي الدراسة. كذلك فإن معاملات التسميد النتروجين سواء أرضى أو رشاً أدت إلى زيادة محتوى الأوراق والبراعم من النتروجين وذلك مقارنة بالعينات المأخوذة من أشجار المقارنة . وقد أظهرت كل معاملات التسميد النتروجين أن تركيز النتروجين في الأوراق والبراعم كان أقل من المعدلات الموصى بها وهى من ٢,٢إلى ٢,٤% في أشجار أصناف التفاح المختلفة. وقد أظهرت نتائج تحليل الأوراق إلى أن إضافة النتروجين سواء أرضى أو رشا خاصة التركيزات العالية أدت إلى انخفاض محتوى الأوراق من الفوسفور والحديد والزنك بينما أدت إلى زيادة محتوى الأوراق من البوتاسيوم , ماغنسيوم والمنجنيز وذلك بالمقارنة بمعاملة الكونترول في كلا موسمي الدراسة. كما أظهرت نتائج الدراسة أن التسميد النتروجين الأرضي أو الرش أدت إلى زيادة في المحصول الكلى ووزن الثمار خاصة في الموسم الثاني بالمقارنة بمعاملة الكونترول. وانخفضت درجة صلابة الثمار بمعدل من ٢/١ إلى ١ رطل / بوصة المربعة مع كل معاملات النتروجين وذلك مقارنة بمعاملة الكونترول والاختلافات كانت في الغالب غير معنوية بين معاملات الرش باليوريا من ناحية, وأيضا غير معنوية بين معاملات التسميد الأرضي من ناحية أخرى .أيضاً كثافة اللون الأحمر في الثمار مقدرة كصبغة الأنثوسيانين انخفضت مع كل معاملات النتروجين وهى لم تكن ثابتة من سنه لأخرى . كما اختلفت نتائج المواد الصلبة الكلية والسكريات الكلية والحموضة في كلا موسمي الدراسة وكانت النتائج غير ثابتة . في نفس الوقت فإن معاملات النتروجين أدت إلى زيادة النسبة المئوية للنشا في الثمار وقت الجمع وذلك بالمقارنة بمعاملة الكونترول في كلا موسمي الدراسة.