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EFFECT OF SOME SOURCES AND RATES OF NITROGEN FERTILIZERS ON PRODUCTIVITY AND LEAF CHARACTERISTICS OF THOMPSON SEEDLESS GRAPEVINES

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ABSTRACT: During 2002 and 2003 seasons, 18-year-old, cane trained Thompson Seedless grapevines, which grown in clay soil received 15 nitrogen fertilization treatments; viz, the possible combinations between five N sources [Urea formaldehyde (UF), urea (U), U + nitrification inhibitor (AM), ammonium nitrate (AN) and AN + AM] each at three rates (60, 80 and 100 g N / vine / year). The main objective was to assess their relative beneficial effects on the yield, fruit quality and leaf characteristics.

The best fruiting and leaf characteristics were obtained by the uppermost tested rate (100 g N/vine/year) from the following nitrogen sources: U + AM, AN and AN + AM. However, the vine behavior was clearly better in the second season compared with the first one with the treatment comprising AM. In addition, soil analysis for the residual N showed better results with AM treatment at higher N rate.

So, it could be recommended to use (U + AM) or (AN + AM) at the rate of 100 g N/vine/year for adult Thompson Seedless vines which grow under similar conditions of the present experiment to achieve better fruiting and leaf characteristics.

Key words: grapevine, nitrogen fertilizers, nitrification inhibitor, yield and leaf characteristics

INTRODUCTION

In Egypt, the area under grapevines reached 141,233 feddans*. Thompson Seedless is one of the most popular grape cvs in Egypt. The optimum nitrogen rate applied to table grapes usually ranges between 40 and 100 g /vine/year, depending on soil type, climate and cultivar (Habeeb *et.al.*, 1986; Khalil *et.al.*, 1989). Yagodin (1984) observed some N losses

* Statistics of Ministry of Agric.,2000 Egypt

from the soil by ammonia volatilization, fixation by clay mineral entrapment, immobilization by bacteria, and the leaching of nitrates. Thus, during the last few years several controlled-release fertilizers such as urea formaldehyde were developed mainly to improve the efficiency of N fertilization through minimizing the nutrient losses via the above mentioned factors. However, the slow release N fertilizers are still much more expensive than the conventional fast release ones.

Most of the fast release N fertilizer used all over the world are ammonium based (urea, ammonium nitrate, etc.). Nitrification is the oxidation of ammonium to nitrate by nitrifying organisms, while the biological denitrification is the reduction of nitrate to produce nitrous oxide and N_2. However, gaseous emissions of N via ammonia (NH_3) volatilization and denitrification have been identified as the dominant mechanisms of fertilizer N loss in many different agricultural systems (Peoples *et.al.*, 1995). The rate of NH_3 volatilization or denitrification can be greatly affected by the choice of N-carrier, although there may be an interaction with soil type or environment. The amount of N lost as NH_3 from urea is frequently much higher than that lost from ammonium nitrate (Stevens and Laughlin, 1989; Malhi and Nyborg, 1992). One mechanism of maintaining added N as ammonium is to add a nitrification inhibitor with the fertilizer (Bundy and Bremner, 1973; Sahrawat *et.al.*, 1987). Numerous substances have been tested for their ability to inhibit nitrification, and several of these have been patented. Only a limited number of chemicals are available commercially for use in agriculture. These include 2-amino-4-chloro-6-methyl pyrimidine (AM), which reduces the emission of nitrous oxide (N_2O) to 24 % less than that of urea (Pathak and Nedwell, 2001). It was used to inhibit the first step of nitrification process (inhibit Nitrosomonas bacteria that convert NH_4^+ to NO_2^-) that increase the persistence of NH_4-N in the soil and decreased the amount of NO_3-N leached from bare soil as reported by Osman (1985).

Thus, the main objective of this study was to pilot the possibility of reducing the used rate of ammonium nitrate or urea by adding the compound AM during fertilization or using slow release fertilizer urea formaldehyde.

MATERIALS AND METHODS

This work was carried out during the two consecutive seasons of 2002 and 2003 on 18-year-old Thompson Seedless grapevines (*Vitis Vinifera L.*) grown on clay soil at 2 × 2.5 meters apart and trained according to the cane-pruning system in a private vineyard at El-Halabi region, Sharkia Governorate. The vineyard soil sample was mechanically and chemically analyzed according to the methods outlined by (Black *et. al.,* 1965). As such, the physical and chemical characteristics of the surface soil (0-30 cm) under investigation was as follows: pH of (1 : 2.5 soil/water) = 7.8, $CaCO_3$ % = 1.8, EC (dSm^{-1}) = 1.4, sand (%) = 12, silt (%) = 42, clay (%) = 46, available N (KCl-extractable) = 7.0 mg/100 g soil. The experimental vines were healthy, almost similar in vigor and were pruned in the second week of January in each season leaving 72 buds / vine (6 fruiting canes × 10 buds plus 6 renewals spurs × 2 buds). All tested vines received all the recommended regular horticultural practices, except those related to nitrogen fertilization treatments included in this work. For this study, 45 uniform vines (15 treatments with three replicates for each) were used. The treatments were the possible combinations between five N sources: urea formaldehyde (UF)(40% N), urea (U) (46.5% N), urea +AM (U+AM), Ammonium Nitrate (AN) (33.5% N), and ammonium nitrate + AM (AN+AM), and each of the considered N sources was applied and incorporated into the soil at three rates (60, 80 and 100 g / vine / year). In both seasons, all tested N-fertilization treatments were added as two equal doses, the first dose at the beginning of growing season (mid February) and the second one was added after fruit set (early May), except for the slow-release nitrogen fertilizer (UF) which was added as a single application at the beginning of flowering. The nitrification inhibitor AM (2-amino-4chloro - 6 methyl pyrimidine) was used at the rate of 3% of the added N fertilizer weight. Vines of each treatment were surrounded with a belt of untreated vines. The following parameters were used to evaluate the effect of tested treatments:

1. Yield Components:

At harvesting time (the second half of July in both seasons), the number of clusters per vine and their total weight (i.e. the yield / vine in kg) were recorded and the average cluster weight was calculated.

2. Cluster, Berry And Juice Characteristics

At harvest time, three clusters per each vine were randomly sampled to determine the following parameters: cluster length and width (cm), number of berries per cluster and fresh weight of 100 berries (g). Moreover, the following chemical constituents in berry juice were determined: percent of total soluble solids (TSS) using a hand refractometer, total titratable acidity by titration against 0.1 *N* sodium hydroxide in the presence of phenolphthalein dye (A.O.A.C., 1985) and the TSS / acid ratio was calculated.

3. Some Leaf Characteristics

In both seasons, leaf samples (20 leaves / replicate) located opposite to the first cluster on each shoot were collected in the first week of July. The largest leaf diameter was measured and the leaf area was calculated using the following equation: $[3.14 \times (\text{diameter})^2/4]$ (Sourial *et al.*, 1985).

In addition, in the same leaf blade samples, were used to determine the content of leaf photosynthetic pigments; i.e., chlorophyll-a, chlorophyll-b and carotenoids as mg / g fresh weight according to Wettestein (1957).

The fresh weight of leaf blades was determined, then the blades and petioles samples were thoroughly washed with distilled water and dried at 70°C until constant dry weight. The leaf blade dry weight was recorded. Water content per unit leaf blade dry matter (hydration ratio) was calculated. The petioles dry samples of each replicate were finely grinded and digested for N, P and K determinations. Nitrogen was determined using the micro-Kjeldahl method, Potassium was determined using flame photometer and phosphorus was determined calorimetrically according to the methods described by Chapman and Pratt (1961).

4. Ammonia And Nitrate Residues In Soil

After harvesting in the second season (2003), soil samples were taken from each plot. The ammonium and nitrate residues (mg/100g soil) at two depths (0-30 and 30-60 cm) were determined using magnesium oxide-Devarda alloy method described by Black *et al.* (1965).

The obtained data were statistically analyzed according to the complete randomized block design with three replicates (Snedecor and Cochran, 1980). The individual comparisons between the obtained means were carried out by LSD method at 5% level.

RESULTS AND DISCUSSION

1. Yield Components

Table 1 show the effect of N source and rate on number of clusters/vine, cluster weight and the yield /vine of Thompson Seedless grape.

1.1 Number of clusters per vine

The number of clusters / vine ranged from 18.0 to 21.7, in the first season, and from 19.3 to 25.0, in the second season, according to tested treatment. The data revealed insignificant differences among all tested treatments in the first season. This was quite expected since the fruitful buds were initiated in the previous summer. In the second season, however, the number of clusters/ vine were, generally, higher than in the first season, which might be due to the effect of N- fertilizers applied in the first season. The greatest numbers of clusters were obtained on vines of (AN+AM), (AN) and (U+AM) without significant differences among them. The least value came from(UF), while (U) gave in-between value.

The data also showed that the number of clusters per vine was significantly increased with increasing N-rate. The greatest values (23.8 and 23.3) were obtained with the medium and uppermost rates (80 and 100 g N/ vine / year).

The interaction between N-sources and N-rates was insignificant.

1.2 Cluster weight

The average cluster weight ranged from 440.0 to 558.3g in the first season and from 530.0 to 640.3 g in the second one (Table 1). The general increase in cluster weight in the second season compared to the first one might be due to accumulation of the available nitrogen in the soil. The effect of N-sources was significant in both seasons. In both seasons, the lightest clusters were obtained by UF ascendingly followed by U. In the first season, the heaviest clusters were obtained by U+AM, AN and AN+AM without significant differences among them. In the second season, the heaviest cluster resulted from two treatments only; i.e., U+AM and AN (Table 1).

The tested N rates also significantly affected cluster weight. The highest values; i.e., 525.0 and 535.3 g in the first season and 600.2 and 603.6 g in the second one resulted from the higher two N rates; i.e., 80 and

Table 1. Effect of some nitrogen sources and rates on number of clusters per vine, cluster weight and yield per vine of Thompson Seedless grape

Nitrogen rate g/vine / Nitrogen sources	Number of cluster / vine			Nitrogen source av.	Cluster weight (g)			Nitrogen source av.	Yield / vine (kg)			Nitrogen source av.
	60	80	100		60	80	100		60	80	100	
First Season (2002)												
Urea formaldehyde (UF)	18.0	20.3	18.7	19.0	440.0	470.7	496.3	469.0	7.92	9.57	9.29	8.93
Urea (U)	18.7	21.0	21.7	20.4	481.3	530.8	540.3	517.5	8.99	11.17	11.70	10.62
U+AM*	19.7	18.0	20.7	19.4	510.7	553.3	547.3	537.1	10.04	9.93	11.29	10.42
Ammonium nitrate (AN)	21.3	20.7	19.7	20.6	506.0	521.7	534.0	520.6	10.76	10.76	10.51	10.67
AN + AM	20.0	21.0	21.7	20.9	520.0	548.3	558.3	542.2	10.90	12.08	12.63	11.87
Nitrogen rate av.	19.5	20.2	20.5		491.6	525.0	535.3		9.72	10.70	11.08	
LSD at 0.05 for	Source	Rate	Source × rate		Source	Rate	Source × rate		Source	Rate	Source × rate	
	NS	NS	NS		21.93	16.16	NS		1.14	0.58	NS	
Second Season (2003)												
Urea formaldehyde (UF)	19.3	22.7	21.3	21.1	560.3	603.8	587.0	583.7	10.83	13.68	12.50	12.34
Urea (U)	20.7	23.0	24.0	22.6	530.0	565.4	594.3	563.2	10.96	12.99	14.24	12.73
U+AM*	21.3	23.7	24.3	23.1	610.2	640.3	625.5	625.3	13.01	15.16	15.22	14.47
Ammonium nitrate (AN)	22.7	24.7	23.0	23.4	600.5	590.9	620.6	604.0	13.62	14.57	14.27	14.15
AN + AM	23.0	25.0	23.7	23.9	540.4	600.6	590.5	577.2	12.43	15.02	13.99	13.81
Nitrogen rate av.	21.4	23.8	23.3		568.3	600.2	603.6		12.17	14.28	14.04	
LSD at 0.05 for	Source	Rate	Source × rate		Source	Rate	Source × rate		Source	Rate	Source × rate	
	1.30	0.89	NS		32.66	14.73	NS		0.75	0.67	NS	

* AM: Nitrification inhibitor (2-amino-4 chloro-6 methyl pyrimidine)

100g N/ vine/year in the 1st and 2nd seasons, respectively without significant differences between them. The lowermost tested rate (60 g N/vine/year) gave the least cluster weight (491.6 and 568.3 g in the 1st and 2nd seasons, respectively).

The interaction between the two studied factors (N-sources and rates) was insignificant in both seasons.

1.3 The yield /vine

Data in Table 1 reveal also that the yield /vine, generally, ranged from 7.92 to 12.63 kg, in the first season, and from 10.83 to 15.22 kg, in the second one. The yield/vine was significantly affected by both N-sources and application rates in both seasons. In the first season, the highest yield (11.87 kg) was obtained by AN + AM. The lowermost yield was obtained by UF while, U, U + AM and AN gave in-between values without significant differences among them. In the second season, the highest yield was obtained by U+AM, AN and AN+AM. The yield / vine with those treatments ranged from 13.81 to 14.47 kg without significant differences among them. The lowermost yields were obtained by UF and U without significant differences between them.

Increasing N-fertilization rates significantly increased the yield in both seasons. The highest yields 10.70 and 11.08 kg /vine. in the 1st season, and 14.28 and 14.04 kg/vine, in the 2nd season, were obtained by the two higher N rates without significant differences between them. The lowest yields (9.72 and 12.17 kg/vine in the two seasons) resulted from vines received the lowermost N rate (60 g N/vine/year) in the two seasons.

The interaction between the two studied factors was insignificant in the two seasons.

Therefore, it could be recommended to apply 80 g N/vine/year to mature Thompson Seedless vines, since results of 80 and 100 g N/vine/year were statistically similar. The source of N could be U + AM or AN + AM.

Concerning the effect of N-sources on yield components, it seems that UF and U were less effective than the other tested N-sources. This may be due to that the rate at which nitrogen is liberated from the slow release fertilizer UF does not always corresponded to the needs of most crops throughout the vegetation period (Yagodin, 1984). Whereas, the lower effectiveness of urea may be due to that the amount of N lost as NH_3 from urea, is frequently much higher than that

Table 2. Effect of some nitrogen sources and rates on cluster length, width and number of berries per cluster of Thompson Seedless grape

Nitrogen rate g/vine / Nitrogen sources	Cluster length (cm)			Nitrogen source av.	Cluster width (cm)			Nitrogen source av.	No of berries / cluster			Nitrogen source av.
	60	80	100		60	80	100		60	80	100	
First Season (2002)												
Urea formaldehyde (UF)	21.2	22.2	20.9	21.4	13.2	14.1	13.0	13.4	217.2	227.3	251.9	232.1
Urea (U)	25.8	26.6	26.9	26.4	16.3	15.3	15.9	15.8	289.4	265.1	278.0	277.5
U+AM*	22.3	22.5	26.0	23.6	13.4	14.7	15.0	14.4	292.6	289.5	255.0	279.1
Ammonium nitrate (AN)	21.6	22.8	25.4	23.3	13.6	13.8	17.0	14.8	311.9	305.0	290.3	302.4
AN + AM	26.3	25.2	26.5	26.0	16.2	15.2	15.8	15.7	361.7	303.3	261.7	308.9
Nitrogen rate av.	23.4	23.9	25.1		14.5	14.6	15.3		294.6	278.1	267.4	
LSD at 0.05 for	Source	Rate	Source × rate		Source	Rate	Source × rate		Source	Rate	Source × rate	
	2.85	NS	NS		1.55	NS	NS		12.85	14.99	33.51	
Second Season (2003)												
Urea formaldehyde (UF)	27.0	28.5	24.7	26.7	16.8	18.0	15.3	16.7	295.5	310.1	303.2	302.9
Urea (U)	28.3	28.3	29.5	28.7	18.0	16.3	17.5	17.3	301.9	295.2	292.9	296.7
U+AM*	26.7	26.2	29.7	27.5	16.0	17.0	17.2	16.7	320.0	324.3	303.3	315.9
Ammonium nitrate (AN)	25.5	25.7	29.5	26.9	16.2	15.7	19.7	17.2	334.4	306.3	323.9	321.5
AN + AM	27.3	27.7	28.0	27.7	16.8	16.7	16.7	16.7	305.3	315.5	279.5	300.1
Nitrogen rate av.	27.0	27.3	28.3		16.8	16.7	17.3		311.4	310.3	300.6	
LSD at 0.05 for	Source	Rate	Source × rate		Source	Rate	Source × rate		Source	Rate	Source × rate	
	NS	NS	NS		NS	NS	NS		8.36	6.70	14.97	

* AM: Nitrification inhibitor (2-amino-4 chloro-6 methyl pyrimidine)

lost from ammonium nitrate. In addition it has been established that urea itself may be leached out of the soil before undergoing ammonification (Peoples *et.al.*, 1995). The effectiveness of adding nitrification inhibitor (AM) to both U and AN fertilizers may be due to inhibiting the oxidation of NH_4^+ to NO_3^- and thereby reducing the losses of N_2O during nitrification and dinitrification processes (Pathak and Nedwell, 2001).

In this respect, the obtained results are in agreement with those reported by Gobara *et.al.* (1998) on Red Roomy grapevines, who found that vines fertilized with urea produced the lowest cluster weight and yield/vine as compared to ammonium sulphate and four other slow release urea fertilizers.

Concerning the effect of N-rate on yield components, the obtained results are in harmony with those reported by several investigators who found that grapevine yield increased with increasing N fertilization rate (Akl *et.al.*, 1993b on White Banaty Seedless cv; Mansour, 1998 on Banaty grapevine; Gobara *et.al.*, 1998 on Red Roomy cv, Abou Sayed Ahmed, *et al.*, 2000a on Thompson Seedless cv, Al-Khayat and Al-Dujaili, 2001 on Kamali and Halwani grape cvs, Keller *et al.*, 2001a on Muller-Thurgau grape cv).

2. Cluster Characteristics

Table 2 demonstrates cluster length, width and number of berries/cluster of Thompson Seedless grape as affected by the tested sources and rates of N-fertilization in seasons 2002 and 2003.

2.1 Cluster dimensions

The data show similar trend for both cluster length and width. The cluster length ranged from 20.9 to 26.9 cm, in the first season and from 24.7 to 29.7 cm in the second season. The cluster width ranged from 13.0 to 17.0 cm in the first season and from 15.3 to 19.7 cm in the second season according to the treatments. The higher cluster dimensions in the second season compared to the first one, might be due to the accumulation of the available nitrogen in the soil.

For both length and width, the only significant differences were due to fertilizer sources in the first season, while the effect of rates and the interaction were always insignificant. Thus, UF gave shorter and thinner clusters as compared with other tested treatments.

Generally, both cluster length and width were increased by the fast release N-fertilizers (U and AN), each alone or with (AM), this was particularly clear in the first season.

2.2 Number of berries per cluster

The number of berries per cluster generally ranged from 217.2 to 361.7, in the first season and from 279.5 to 334.4, in the second one, according to tested treatments (Table 2).

The data reveal also that all N-sources, N-rates and their interaction affected number of berries per cluster significantly in the two seasons. As for N-sources, treatments that consistently gained the highest numbers of berries per cluster through the two seasons were AN and AN+AM without significant differences between them. In the second rank came U+AM, while the least numbers were obtained by UF and U. In this respect, it is clear that adding AM improved the effect of urea on the number of berries per cluster especially in the second season.

Regarding the N-rate, the highest numbers of berries per cluster (294.6 and 311.4) were obtained by the lowermost N-rate (60 g N/vine/year) in the first and second seasons, respectively. Meanwhile, the least numbers of berries per cluster (267.4 and 300.6) were obtained by the highest N-rate(100 g N/vine/year).

The interaction between the two studied factors was significant in the two seasons. The highest number of berries/cluster (361.7) was recorded for the (low N-rate + AN + AM) in the first season. In the second one, the highest number of berries per cluster (334.4) was recorded for the (low N-rate + AN).

The available literature did not regard the effect of N-sources and rates of fertilization on the cluster dimension and number of berries per cluster under consideration.

3. Berry Physical And Chemical Characteristics

Table 3 shows the 100-berry weight as well as juice TSS, acidity and TSS/ acid ratio as affected by some sources and rates of N fertilization in 2002 and 2003 seasons.

3.1 100-berry weight

The weight of 100-berries, generally, ranged from 141.7 to 214.3, in the first season, and from 170.0 to 205.0, in the second season according to the tested treatments. It is clear that all of N-sources, N-rates and their interactions caused pronounced effect on the 100-berry weight in both seasons.

As for N-sources, the treatments that consistently gave higher 100-berry weights in the two seasons were: UF (196.2 and 191.0 g) and U+AM (189.1and 192.7g) in the two seasons.

Table 3. Effect of some nitrogen sources and rates on 100-berry weight, juice TSS, total acidity and TSS/acid ratio of Thompson Seedless grape

Nitrogen rate g/vine / Nitrogen source	100-berry weight (g) 60	80	100	Nitrogen source av.	TSS (%) 60	80	100	Nitrogen source av.	Total Acidity (%) 60	80	100	Nitrogen source av.	TSS/acid ratio 60	80	100	Nitrogen source av.
First Season (2002)																
Urea formaldehyde (UF)	194.3	200.7	193.7	196.2	19.2	19.4	18.5	19.0	0.60	0.62	0.64	0.62	32.0	31.3	28.9	30.6
Urea (U)	158.7	194.7	190.0	181.1	18.9	18.4	18.2	18.5	0.60	0.67	0.68	0.65	31.5	27.5	26.8	28.5
U+AM*	170.7	186.0	210.7	189.1	17.8	17.4	17.3	17.5	0.58	0.65	0.66	0.63	30.7	26.8	26.2	27.8
Ammonium nitrate (AN)	157.7	173.0	178.7	169.8	18.0	18.0	17.4	17.8	0.60	0.65	0.70	0.65	30.0	27.7	24.9	27.4
AN + AM	141.7	174.7	214.3	176.9	17.6	17.5	17.4	17.5	0.60	0.64	0.68	0.64	29.3	27.3	25.6	27.3
Nitrogen rate av.	164.6	185.8	197.5		18.3	18.1	17.8		0.60	0.65	0.67		30.7	28.1	26.5	
LSD at 0.05 for	Source 9.08	Rate 7.43		S. × R. 16.60	Source 0.28	Rate 0.19		S. × R. NS	Source NS	Rate 0.01		S. × R. NS	Source 0.82	Rate 0.74		S. × R. NS
Second Season (2003)																
Urea formaldehyde (UF)	185.0	190.0	198.0	191.0	19.8	19.6	19.0	19.5	0.55	0.60	0.65	0.60	36.0	32.7	29.2	32.4
Urea (U)	170.0	185.0	195.0	183.3	18.5	18.2	17.9	18.2	0.58	0.62	0.66	0.62	31.9	29.4	27.1	29.4
U+AM*	186.0	192.0	200.0	192.7	19.6	18.2	18.0	18.4	0.56	0.64	0.72	0.64	35.0	28.4	25.0	28.8
Ammonium nitrate (AN)	176.0	188.0	185.0	183.0	18.4	18.0	17.2	17.9	0.58	0.64	0.70	0.64	31.7	28.1	24.6	27.9
AN + AM	172.0	185.0	205.0	187.3	18.2	17.6	17.8	17.9	0.58	0.63	0.68	0.63	31.4	27.9	26.2	28.4
Nitrogen rate av.	177.8	188.0	196.6		18.9	18.3	18.0		0.57	0.63	0.68		33.2	29.3	26.4	
LSD at 0.05 for	Source 6.01	Rate 4.08		S. × R. 9.13	Source 0.24	Rate 0.16		S. × R. 0.36	Source NS	Rate 0.02		S. × R. NS	Source 1.22	Rate 1.14		S. × R. NS

* AM : Nitrification inhibitor (2-amino-4 chloro-6 methyl pyrimidine)

respectively without significant differences between them in each season. It is worthy to mention that both the above mentioned treatments recorded lower number of berries/ cluster compared to other tested treatments. On the other hand, the AN treatment recorded lower 100-berry weights in the two experimental seasons.

Regarding N-rate effect, the data indicated that the highest 100-berry weight (197.5 and 196.6 g in the two seasons) resulted from the uppermost tested N-rate (100g N / vine / year). Meanwhile, the least values (164.6 and 177.8 g in the two seasons) were gained by the lowermost N-rate (60g N / vine / year).The differences between the two N-rates were significant in both seasons. The medium N-rate (80g N / vine / year) recorded intermediate 100-berry weights in both seasons.

The interaction between the two studied factors was significant in the two seasons. In the first season, the highest 100-berry weights were gained by the combined treatments : (UF×60,80 and 100 g N), (U×80 and 100 g N), (U+AM×100g N) and (AN + AM×100g N) without significant differences among them. In the second season, the highest 100-berry weight came from the treatments: (UF× 100g N), (U+AM × 100g N) and (AN+AM× 100gN) without significant differences among them. On the other hand, the least values always came from the treatments: (U× 60 g N), (AN× 60g N) and (AN+AM × 60gN) without significant differences among them.

The obtained findings concerning the effect of N-rate on 100 berry weight are in agreement with those reported by Ahlawat and Yamdagni (1988) on Perlitte cv, Mansour (1998) working on Banaty cv and Abou Sayed Ahmed *et al.*, (2000a) on Thompson Seedless cv They all reported that increasing N-fertilization rate increased 100 berry weight.

3.2 Total soluble solids (TSS)

TSS in berry juice ranged from 17.3 to 19.4 % in the first season and from 17.2 to 19.8 % in the second one. TSS percentage was significantly affected by the N-sources in both seasons. Treated vines with UF gave the highest TSS percentages (19.0 and 19.5 % in the first and second seasons, respectively).On the other hand, treated vines with AN and AN+AM gave the least TSS percentages (17.8 and 17.9% with AN and 17.5 and 17.9% with AN+AM in the first and second seasons, respectively). In this respect, the differences between

UF and all other tested N-sources were significant in both seasons.

The effect of N-rate was also significant in both seasons since, the highest TSS% came from the lowermost N-rate (60g/vine/year), while, the least values were recorded by the uppermost N-rate(100 g N /vine / year).

The interaction between N-sources and rates was significant in the second season only, when the highest TSS percentages were gained by the combined treatments (UF ×60 g N),(UF× 80gN) and (U+AM× 60 g N) without significant differences between them. The least TSS values came from (AN × 100 g N).

3.3 Total acidity percentage

Total acidity percentage in berry juice ranged from 0.58 to 0.70 %, in the first season, and from 0.55 to 0.72 %, in the second one. The effect of N-sources on juice acidity was insignificant in both seasons. However, the juice acidity percentage was significantly increased in both seasons as N-fertilization rate increased. The uppermost and lowermost tested N-rates gave the highest (0.67 and 0.68 %) and lowest (0.60 and 0.57 %) juice acidity percentages in the first and second seasons, respectively. In this respect, the differences between the medium and high N-rates were significant in both seasons.

The effect of the interaction between the N-sources and rates was insignificant in both seasons.

3.4 TSS / acid ratio

The data show that TSS/acid ratio in berry juice ranged from 24.9 to 32.0, in the first season, and from 24.6 to 36.0, in the second one. Nitrogen sources affected the juice TSS/acid ratio significantly in both seasons. The highest TSS/acid ratio (30.6 and 32.4in the two seasons) was obtained by UF. The least values (27.8,27.4 and 27.3 in the first season and 28.8, 27.9 and 28.4 in the second one) were resulted from the treatments U+AM, AN and AN+AM, without significant differences among them in both seasons. The differences in TSS/acid ratio between the vines treated with UF and any of the other tested N-sources were significant through the two seasons.

As for N-rates effect, the TSS/acid ratio was significantly decreased with increasing N-rates in both seasons. The highest TSS/acid ratios (30.7 and 33.2in the two seasons) were obtained by the lowermost N-rate (60 g N /vine/ year) ,while the lowest ratios

(26.5 and 26.4in the two seasons) were resulted from the uppermost tested N-rate (100 g N/ vine/year). Moreover, the differences in TSS/acid ratio among the high, medium and low N-rates were significant in both seasons.

The interaction between the studied two factors (N-sources × N-rates) was insignificant in both seasons.

The obtained results concerning the effect of N fertilization rate on juice TSS and acidity are in harmony with those found by Ahlawat and Yamdagni (1988), Kliewer (1991), Akl *et al.* (1993b), Kliewer *et al.* (1994) and Abou Sayed Ahmed *et al.* (2000a) working on different grapevines cultivars. They all reported that increasing N fertilization rate decreased berry juice TSS and increased total juice acidity and TSS/acid ratio.

4. Leaf Characteristics

Table 4 represents the effect of tested N- sources and rates on leaf area (cm^2), leaf fresh and dry weight (g) and hydration ratio in the two experimental seasons (2002 and 2003).

4.1 Leaf area

The leaf area, generally, ranged from 151.09 to 187.50 cm^2 and from 163.32 to 220.46 cm^2 in the first and second seasons, respectively.

The effect of N-sources on leaf area was significant in the second season only. The largest leaf area (211.86 and197.45 cm^2) came from AN+AM and U without significant differences between them, while, the smallest leaf area (178.93, 183.38 and 183.51 cm^2) were resulted from U+AM, AN and UF without significant differences among them.

The tested N-rates affected leaf area significantly in both seasons. The uppermost tested N-rate (100 g/vine) gave The largest leaves (179.91 and 199.37 cm^2 in the first and second seasons, respectively). The smallest leaves resulted from the lowermost N-rate (60 g/vine) (162.88 and 181.97 cm^2 in the two seasons). The medium N-rate(80 g/vine) gave in-between values being statistically similar to the lower rate in the first season and similar to the higher rate in the second one.

The interaction between N-sources and rates was insignificant in the two seasons regarding leaf area.

Concerning the effect of N-rate on leaf area, the obtained results are in harmony with those reported by Akl *et al.* (1993a) who reported that increasing soil application rate of urea up to 300 g/vine

Table 4 . Effect of some nitrogen sources and rates on leaf area, leaf fresh and dry weights and hydration ratio in Thompson Seedless grapevines

Nitrogen rate g/vine / Nitrogen sources	Leaf area (cm^2)			Nitrogen source av.	Leaf fresh weight (g)			Nitrogen source av.	Leaf dry weight (g)			Nitrogen source av.	Hydration ratio			Nitrogen source av.
	60	80	100		60	80	100		60	80	100		60	80	100	
First Season (2002)																
Urea formaldehyde (UF)	165.76	177.16	168.93	170.62	3.09	3.36	3.07	3.17	0.84	0.92	0.87	0.88	2.66	2.66	2.56	2.62
Urea (U)	177.22	177.65	179.95	178.27	3.20	3.23	3.42	3.28	0.86	0.85	0.94	0.88	2.73	2.80	2.65	2.73
U+AM*	151.09	174.23	183.69	169.67	3.03	3.49	3.60	3.37	0.84	0.90	0.96	0.90	2.62	2.90	2.75	2.75
Ammonium nitrate (AN)	164.67	160.29	187.50	170.82	3.10	3.43	3.39	3.31	0.82	0.84	0.94	0.87	2.76	3.16	2.60	2.84
AN + AM	155.68	154.61	179.46	163.25	3.08	3.22	3.37	3.22	0.85	0.67	0.94	0.82	2.63	3.84	2.60	3.02
Nitrogen rate av.	162.88	168.79	179.91		3.10	3.35	3.37		0.84	0.83	0.93		2.68	3.07	2.63	
LSD at 0.05 for	Source	Rate		S. × R.	Source	Rate		S. × R.	Source	Rate		S. × R.	Source	Rate		S. × R.
	NS	9.68		NS	NS	0.15		NS	NS	0.05		0.12	0.21	0.16		0.35
Second Season (2003)																
Urea formaldehyde (UF)	189.23	186.19	175.11	183.51	3.55	3.53	3.20	3.43	1.00	1.02	0.90	0.97	2.54	2.45	2.57	2.52
Urea (U)	190.91	200.72	200.73	197.45	3.45	3.64	3.82	3.64	0.97	1.00	0.99	0.99	2.56	2.63	2.85	2.68
U+AM*	163.32	176.11	197.37	178.93	3.29	3.53	3.87	3.56	0.86	0.88	1.11	0.95	2.85	3.01	2.51	2.79
Ammonium nitrate (AN)	171.68	175.29	203.16	183.38	3.23	3.76	3.67	3.55	0.83	1.03	1.00	0.95	2.88	2.65	2.67	2.73
AN + AM	194.71	220.42	220.46	211.86	3.85	4.60	4.14	4.20	0.97	1.16	1.08	1.07	2.97	2.97	2.82	2.92
Nitrogen rate av.	181.97	191.75	199.37		3.47	3.81	3.74		0.93	1.02	1.02		2.76	2.74	2.69	
LSD at 0.05 for	Source	Rate		S. × R.	Source	Rate		S. × R.	Source	Rate		S. × R.	Source	Rate		S. × R.
	19.38	10.08		NS	0.33	0.26		NS	NS	0.08		NS	0.16	NS		0.21

* AM : Nitrification inhibitor (2-amino-4 chloro-6 methyl pyrimidine)

significantly increased leaf area of White Banaty Seedless grapevines. In addition, Mansour (1998) working on Banaty grapevine, revealed that raising urea fertilization levels up to 160 g/vine significantly increased leaf area. Moreover, Keller *et al.* (2001b) reported that the highest nitrogen fertilization rate (100 kg N/ha) increased leaf area of the Maller Thurgau grape cultivar.

In this respect, increasing leaf area due to increasing N-rate, could be attributed not only to N role in protein synthesis but also to its role in cellulose and lignin synthesis which encourage cell division and the development of new tissues as reported by Nijjar (1985).

4.2 Leaf fresh weight

The leaf fresh weight, generally, ranged from 3.03 to 3.60 g and from 3.20 to 4.60 g in the first and second seasons, respectively.

The tested N-sources affected the leaf fresh weight significantly in the second season only. The highest value (4.20 g) was gained by AN+AM. Meantime, the other tested N-sources gave lower values without significant differences among them.

The tested N-rates affected significantly leaf fresh weight in both seasons. The higher two rates (80 and 100 g N)indicated higher leaf fresh weight (3.35 and 3.37g in the first season and3.81 and 3.74 g in the second season) without significant differences between them in each season. Meanwhile. the lowest leaf fresh weight (3.10 and 3.47 g) were gained by the lowermost N-rate (60 g N). in the two seasons.

The interaction between N-sources and rates was insignificant in both seasons.

4.3 Leaf dry weight

The leaf dry weight. generally. ranged from 0.82 to 0.96 g and from 0.83 to 1.16 g in the first and second seasons, respectively.

N-sources had no significant effect on the leaf dry weight in both seasons. However, N-rates significantly affected leaf dry weight; As such, the highest values (0.93 and 1.02 g in the two seasons) were recorded by the uppermost tested rate (100 g N). while the lowest values (0.84 and 0.93 g in the two seasons) were recorded by the lowermost N-rate (60 g N). The medium N-rate (80 g N) was statistically similar to the lower rate in the first season and to the higher rate in the second season.

The interaction between the two tested factors was significant in the first season only. As such.

the highest values came from most of the combined treatment: (UF× all rates), (U × all rates) , (U+AM × all rates), (AN× 80 and 100 g N) and (AN+AM ×60 and 100g N) without significant differences among them.

4.4 Leaf hydration ratio

The leaf hydration ratio, generally, ranged from 2.56 to 3.84 and from 2.45 to 3.01 in the first and second seasons, respectively.

The effect of N-sources was significant in the two seasons. The highest values were obtained by AN and AN + AM in the first season and by AN + AM and U+AM in the second season. The lowest values resulted from UF, U and U + AM in the first season without significant differences among them and by UF in the second season.

The N-rate affected the leaf hydration ratio significantly in the first season only, when the highest leaf hydration ratio was gained by the medium rate (80 g N) as compared with both the lowermost (60 g N) and highermost (100 g N) rates.

The interaction between the two studied factors was significant in the two seasons. In the first season, the highest hydration ratio came from the combined treatment (AN + AM × 80 g N). In the second season the highest values were gained by: U × 100 g N; U + AM × 60 and 80 g N; AN × 60 g N and AN + AM × 60, 80 and 100 g N without significant differences among them. On the other hand, the least values in the first season were recorded by: UF × 60, 80 and 100 g N; U × 60, 80 and 100 g N; U + AM × 60, 80 and 100 g N; AN × 60, 80 and 100 g N and AN + AM × 60 and 100 g N without significant differences among them. In the second season the least values resulted from: UF × 60, 80 and 100 g N; U × 60 and 80 g N; U + AM × 100 g N and AN × 80 and 100 g N.

Generally, the most effective source to encourage leaf area, leaf fresh weight and leaf hydration ratio was AN+AM. In addition, the greatest leaf area and weight were obtained by the uppermost tested N-rate (100gN) as compared with lower rates (60 and 80 g N).

It seems that AN+AM was more efficient in enhancing leaf physical parameters as compared with U+AM. This might be due to that AM is more capable to inhibit nitrification of U rather than AN, which already has a nitrate component.

The obtained results concerning the effect of N fertilization rate on leaf fresh, dry weights and hydration ratio go in line with

Table 5. Effect of some nitrogen sources and rates on photosynthetic pigments contents (mg/g f.w.) in leaf blades of Thompson Seedless grapevines

Nitrogen rate g/vine / Nitrogen source	Chlorophyll a			Nitrogen source av.	Chlorophyll b			Nitrogen source av.	Total chlorophyll			Nitrogen source av.	Carotene			Nitrogen source av.
	60	80	100		60	80	100		60	80	100		60	80	100	
First Season (2002)																
Urea formaldehyde (UF)	0.79	0.70	0.73	0.74	0.66	0.65	0.65	0.65	1.45	1.35	1.38	1.39	0.73	0.69	0.70	0.71
Urea (U)	0.69	0.63	0.71	0.68	0.65	0.61	0.61	0.62	1.34	1.24	1.32	1.30	0.63	0.67	0.67	0.66
U+AM*	0.74	0.73	0.85	0.77	0.67	0.68	0.75	0.70	1.41	1.41	1.60	1.48	0.63	0.64	0.66	0.64
Ammonium nitrate (AN)	0.69	0.76	0.85	0.77	0.63	0.70	0.75	0.70	1.32	1.47	1.60	1.46	0.61	0.68	0.69	0.66
AN + AM	0.72	0.83	0.84	0.80	0.69	0.72	0.76	0.72	1.41	1.54	1.61	1.52	0.67	0.68	0.73	0.69
Nitrogen rate av.	0.73	0.73	0.80		0.66	0.67	0.71		1.39	1.40	1.50		0.65	0.67	0.69	
LSD at 0.05 for	Source	Rate	Source × rate		Source	Rate	Source × rate		Source	Rate	Source × rate		Source	Rate	Source × rate	
	0.05	0.04	0.09		0.03	0.02	0.05		0.08	0.06	0.14		0.05	NS	NS	
Second Season (2003)																
Urea formaldehyde (UF)	0.83	0.73	0.75	0.77	0.70	0.68	0.68	0.69	1.53	1.41	1.43	1.45	0.78	0.78	0.77	0.78
Urea (U)	0.71	0.65	0.72	0.69	0.67	0.62	0.66	0.65	1.38	1.27	1.38	1.34	0.63	0.70	0.72	0.68
U+AM*	0.78	0.75	0.95	0.83	0.73	0.69	0.87	0.76	1.50	1.45	1.81	1.59	0.71	0.66	0.74	0.70
Ammonium nitrate (AN)	0.71	0.79	0.93	0.81	0.62	0.74	0.82	0.73	1.33	1.53	1.75	1.54	0.61	0.70	0.71	0.68
AN + AM	0.79	0.86	0.88	0.84	0.73	0.75	0.81	0.76	1.52	1.60	1.69	1.60	0.72	0.70	0.77	0.73
Nitrogen rate av.	0.76	0.76	0.85		0.69	0.70	0.77		1.45	1.45	1.61		0.69	0.71	0.74	
LSD at 0.05 for	Source	Rate	Source × rate		Source	Rate	Source × rate		Source	Rate	Source × rate		Source	Rate	Source × rate	
	0.08	0.06	NS		0.07	0.05	NS		0.14	0.10	NS		0.06	NS	NS	

* AM : Nitrification inhibitor (2-amino-4 chloro-6 methyl pyrimidine)

those reported by Abou Sayed Ahmed *et al.* (2000 b) on Thompson Seedless. Who reported that increasing N fertilization rate increased leaf fresh and dry weights, while decreased leaf hydration ratio.

The effect of N sources on leaf characteristics of Thompson Seedless grapevines was of no previous data in the available literature.

4.5 Leaf photosynthetic pigments

Table 5 illustrates the effect of N-sources and rates on chlorophyll (a), chlorophyll (b), total chlorophyll and carotenoids contents in leaf blade in 2002 and 2003 seasons.

a. Chlorophyll (a) content

Chlorophyll (a) content, generally, ranged from 0.63 to 0.85 mg/g F.W., in the first season, and from 0.65 to 0.95 mg/g F.W., in the second one. Since, chlorophyll (a) content was significantly affected by both N-sources and rates in the two seasons.

As for N-sources effect, the highest chlorophyll (a) content in both seasons were obtained by U+AM, AN and AN+AM without significant differences among them in both seasons. The least values resulted from UF and U which was true in both seasons.

In addition, the uppermost tested N-rate gave significantly highest (0.80 and 0.85 mg/g F.W., in the 1st and 2nd seasons, respectively) chlorophyll a content in the two seasons as compared to both the lowermost and medium N-rates.

The interaction between the two studied factors was significant in the first season only, when, the highest chlorophyll a content was gained by the combined treatments: (U+AM×100 g N), (AN×80 and 100 g N), (AN+AM× 80 and 100 g N) and (UF × 60 g N) without significant differences among them. The least chlorophyll (a) content resulted from the combined treatments: (U×60, 80 and 100 g N), (AN×60 g N) and (UF×80 g N).

b. Chlorophyll (b) content

The chlorophyll (b) content, generally, ranged from 0.61 to0.76 mg/g F.W. in the first season and from 0.62 to 0.87 mg/g F.W. in the second one.

The N-sources significantly affected chlorophyll (b) content in both seasons. The highest values came from U+AM, AN and AN+AM in both seasons. The least values came from UF and U in both seasons.

As for N-rates effect, the results showed that the highest values (0.71 and 0.77 mg/g F.W.) resulted from the uppermost rate

(100gN), while, the lowest values came from the other two rates (60 and 80 g N) without significant differences between them in each season.

The interaction between the two studied factors was significant in the first season only, when, the highest chlorophyll b content was obtained by the combined treatments of: (U+AM, AN, AN+AM each×100gN) and (AN + AM × 80 g N).

c. Total chlorophyll content

Total chlorophyll content, generally, ranged from 1.24 to 1.60 mg/g F.W., in the first season and from 1.27 to 1.81 mg/g F.W., in the second season.

In both seasons, the highest total chlorophyll content were obtained by the N-sources : U+AM, AN and AN+AM without significant differences among them. As such, the least values resulted from UF and U.

The highest total chlorophyll content were (1.50 and 1.61 mg/g in the two seasons) was gained by the uppermost tested rate (100g N). The other two tested rates (60 and 80 gN) indicated lower total chlorophyll contents in both seasons as compared with the uppermost rate (100gN). Furthermore, the interaction between the two studied factors was significant in the first season only. The highest total chlorophyll contents were obtained by the following combined treatments: U+AM ×100 g N, AN×80 and 100 g N and AN+AM×80 and 100g N.

d. Carotenoids content

The content of carotenoids, generally, ranged from 0.61 to 0.73 mg/g F.W., in the first season, and from 0.61 to0.78 mg/g F.W., in the second one. The tested N-sources affected leaf carotenoids content significantly in the two seasons. The sources that consistently resulted in the highest carotenoids contents in the two seasons were: UF and AN+AM. The other sources gave lower carotenoids content in the two seasons without significant differences among them. Moreover, the effects of N-rates and the interaction (sources× rates) were insignificant in both seasons.

Generally, only three N-sources significantly increased chlorophyll content (a, b, and the total) in leaf blade in both seasons. These treatments were: U+AM, AN and AN+AM. Whereas, the leaf carotenoids content was increased by UF and AN+AM only. In addition, the uppermost N-rate (100gN/vine) clearly increased chlorophyll (a, b and total) content in the leaf blade in the two seasons

Table 6 . Effect of some nitrogen sources and rates on N, P and K percentages in leaf petiole of Thompson Seedless grapevines

Nitrogen rate g/vine / Nitrogen sources	N (%)			Nitrogen source av.	P (%)			Nitrogen source av.	K (%)			Nitrogen source av.
	60	80	100		60	80	100		60	80	100	
First Season (2002)												
Urea formaldehyde (UF)	1.05	1.12	1.26	1.14	0.23	0.24	0.24	0.24	1.83	2.14	2.34	2.10
Urea (U)	1.12	1.18	1.25	1.18	0.17	0.18	0.23	0.19	1.19	1.56	1.29	1.35
U+AM*	1.25	1.28	1.36	1.30	0.22	0.26	0.18	0.22	1.67	2.15	2.10	1.97
Ammonium nitrate (AN)	1.18	1.26	1.33	1.26	0.24	0.37	0.45	0.35	1.44	1.18	1.38	1.33
AN + AM	1.33	1.43	1.48	1.41	0.28	0.27	0.24	0.26	1.55	1.83	1.38	1.59
Nitrogen rate av.	1.19	1.25	1.33		0.23	0.26	0.27		1.54	1.77	1.70	
LSD at 0.05 for	Source	Rate	Source × rate		Source	Rate	Source × rate		Source	Rate	Source × rate	
	0.03	0.02	NS		0.05	0.03	0.08		0.07	0.03	0.08	
Second Season (2003)												
Urea formaldehyde (UF)	1.93	1.01	1.57	1.50	0.27	0.22	0.27	0.25	3.62	3.04	3.23	3.30
Urea (U)	1.62	1.85	1.62	1.70	0.25	0.22	0.21	0.23	3.45	3.57	3.09	3.37
U+AM*	1.60	1.70	1.85	1.72	0.16	0.16	0.16	0.16	2.00	1.89	2.24	2.04
Ammonium nitrate (AN)	1.83	1.83	1.90	1.85	0.17	0.21	0.16	0.18	2.07	2.07	1.78	1.97
AN + AM	1.67	2.09	2.16	1.97	0.16	0.17	0.16	0.16	1.73	1.55	1.71	1.66
Nitrogen rate av.	1.73	1.69	1.82		0.20	0.20	0.19		2.57	2.42	2.41	
LSD at 0.05 for	Source	Rate	Source × rate		Source	Rate	Source × rate		Source	Rate	Source × rate	
	0.14	NS	0.25		0.03	NS	0.02		0.17	0.12	0.26	

* AM : Nitrification inhibitor (2-amino-4 chloro-6 methyl pyrimidine)

as compared to the lower tested rates (60 and 80 g N).

It seems that photosynthetic pigments of Thompson Seedless leaves of the second season was, in general, higher than that of the first one. This may be due to the residual effect of fertilization treatments particularly those treated with AM, which reduced N-losses and increased N-efficiency through regulating N-absorption within growth periods as reported by Awad (1982) and Osman *et al.* (1997) who indicated that adding AM to fast release fertilizers converted it to controlled release fertilizers.

The obtained results concerning the effect of N fertilization rate on leaf photosynthetic pigments are in harmony with those reported by Keller *et al.* (2001 b) who worked on *Vitis vinifera* cv Muller-Thurga. They reported that high nitrogen fertilization level (100 kg N/ha) increased leaf chlorophyll content and photosynthesis.

4.6 Leaf NPK contents

Table 6 discloses the effects of tested N-sources and N-rates on N, P and K % in leaf petioles in 2002 and 2003.

a- N% in leaf petiole

The N percentages in leaf petiole, generally, ranged from 1.05 to 1.48 %, in the first season, and from 1.01 to 2.16 % in the second season. The effect of N-sources was significant in both experimental seasons. The highest N percentages were recorded by AN + AM in the first season and by AN + AM and AN in the second one without significant differences between them. The lowest N percentages resulted from UF in both seasons. The other tested N-sources recorded in between values.

The effect of N-rates was significant in the first season only. As it was expected, the highest N percentages was recorded by the uppermost tested rate (100 g N/ vine/ year) which recorded 1.33 % N in leaf petiole as compared with 1.25 % for the medium rate (80 g N) and 1.19 % for the lowermost rate (60 g N).

The interaction (sources × rates) was also significant in the second season only, the highest N percentages were gained by the combined treatments: UF × 60 g N and AN+AM × 80 and 100 g N. The differences between these treatments were insignificant.

Generally, N percentages in leaf petiole were significantly increased by increasing N rate in the first season. In addition, AN + AM gave consistently highest N percentage throughout the two seasons. Moreover, it seems that leaf petioles in the second season had, in general, higher N percentages as compared to the first one. this also may be due to the residual effect of fertilization treatments particularly those treated with AM, which reduced N losses and increased N efficiency through regulating N absorption within growth periods as reported by Awad (1982) and Osman *et al.* (1997). The results concerning the effect of N rate on leaf petiole N percentages are in harmony with those reported by Habeeb *et al.* (1986) on Romi Ahmar and Thompson Seedless cvs, Ahlawat and Yamdagni (1988) on Perlitte cv, Akl *et al.* (1993 a) on Banaty Seedless cv and Abou Sayed Ahmed *et al.* (2000 b) on Thompson Seedless cultivar.

b- P% in leaf petiole

The P percentages, generally, ranged from 0.17 to 0.45 %, in the first season, and from 0.16 to 0.27 %, in the second season. The effect of N sources was significant in both seasons, but no actual trend could be detected through the two experimental seasons. The highest P percentage resulted from AN in the first season, while it was gained by UF and U in the second season.

The effect of N-rates was clear in the first season only, the higher two rates (80 and 100 g N) resulted in higher blade P percentage as compared with the lowest rate (60 g N).

The interaction (sources × rates) was significant in both seasons, but no actual trend could be detected.

Generally, P percentages in leaf petiole were increased by increasing N rate, in the first season, while no actual trend was observed concerning the effect of N sources on P percentages in leaf petiole.

The obtained results concerning the effect of N-rate on leaf petiole P percentages are in agreement with those reported by Habeeb *et al.* (1986), Ahlawat and Yamdagni (1988) and Akl *et al.* (1993 a).

c- K % in leaf petiole

The K percentages, generally, ranged from 1.19 to 2.34 % in the first season and from 1.55 to 3.62 in the second season. The effect of N sources was significant in both seasons. The highest K percentages resulted from UF in the first season, while it was gained by UF and U in the second season.

The effect of N-rate as well as the interaction (sources × rates) were significant in both seasons, but no actual trend could be detected.

Table 7. Ammonium and nitrate residues at two soil depths (0-30 and 30-60 cm) after harvesting of Thompson Seedless grape in the second season (2003 season)

Nitrogen rate g/vine / Nitrogen sources	Soil depth	NH_4 mg / 100 gm soil			NO_3 mg / 100 gm soil			$NH_4 + NO_3$ mg / 100 gm soil		
		60	80	100	60	80	100	60	80	100
Urea formaldehyde (UF)	0 - 30	2.66	2.56	2.98	3.50	4.64	5.62	6.16	7.20	8.60
	30 - 60	2.80	2.98	2.80	4.90	3.82	5.20	7.70	6.80	8.00
Urea (U)	0 - 30	1.60	2.90	3.40	4.20	4.30	3.20	5.80	7.20	6.60
	30 - 60	1.40	2.90	3.60	4.80	4.60	4.30	6.20	7.50	7.90
U+AM*	0 - 30	2.96	2.00	3.54	5.50	5.34	6.40	8.46	7.34	9.94
	30 - 60	3.20	2.56	3.20	5.10	6.40	6.30	8.30	8.96	9.50
Ammonium nitrate (AN)	0 - 30	1.54	2.24	2.80	4.26	3.80	3.78	5.80	6.04	6.58
	30 - 60	1.70	1.80	2.40	4.40	4.35	4.60	6.10	6.15	7.00
AN + AM	0 - 30	1.82	2.42	2.40	4.06	3.60	6.56	5.88	6.02	8.96
	30 - 60	1.14	2.28	2.10	4.46	4.30	6.58	5.60	6.58	8.68

* AM : Nitrification inhibitor (2-amino-4 chloro-6 methyl pyrimidine)

5- Residual Ammonium And Nitrate In Soil After Harvesting In The Second Season

Data in Table 7 show that remained ammonium and nitrate in soil after harvesting at the end of the experiment were affected by the different nitrogen treatments. At all cases, data reveal that values of nitrate nitrogen were higher than ammonium one at tested two soil depths. Comparing the values as affected by soil depth, data show that $(NH_4 + NO_3)$-N were higher in surface soil (0-30 cm) than subsurface one, particularly with UF, U + AM and AN + AM. That means, slowing release of N-forms due to the effect of the nitrification inhibitor in delaying the process and saving the loss of nitrate via leaching and adsorbing the NH_4^+ on the adsorptive sites of organic matter in the surface layers as reported by Osman *et al.* (1997). In addition, UF fertilizer gave higher values of $(NH_4 + NO_3)$-N in the surface layer due to slowing release of the material and its low activity index as reported by Osman (2004). Opposite direction was observed with urea or AN applied singly, where the values of nitrogen forms were lower in the upper layers than lower ones. due to fast release of N-forms and leaching them from upper to lower layers.

Generally, application of nitrification inhibitor or using slow-release N-fertilizers. increased the residual ammonium and nitrate nitrogen after harvesting more than the fast release sources.

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تأثير بعض مصادر و معدلات الأسمدة الآزوتية على إنتاجية و خصائص أوراق كروم العنب تومسون سيدلس

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خلال موسمى ٢٠٠٢ و ٢٠٠٣ سمدت كروم العنب تومسون سيدلس عمر ١٨ عام و المنزرعة فى تربة طينية و مرباة بالطريقة القصبية بخمس عشرة معاملة تسميد آزوتى، هى عبارة عن التوليفات الممكنة لخمسة مصادر أسمدة نيتروجينية هى [اليوريا فورمالدهيد، و اليوريا ، و اليوريا + مثبط عملية النترتة (AM) ، و نترات الأمونيوم ، و نترات الأمونيوم + (AM)] و ثلاث معدلات للتسميد الآزوتى (٦٠ ، ٨٠ ، ١٠٠ جم نيتروجين / كرمة / سنة) ، و ذلك بهدف تحديد تأثيراتها النسبية المفيدة على المحصول و جودة الثمار و خصائص الأوراق.

و قد أوضحت النتائج المتحصل عليها بإختصار ، أن أفضل إنتاج للثمار و أفضل خصائص للأوراق تم الحصول عليها بإستخدام المصادر النيتروجينية التالية و ذلك عند أعلى معدل مختبر و هو (١٠٠ جم نيتروجين / كرمة / سنة): اليوريا + مثبط النترتة (AM) ، نترات الأمونيوم (AN) ، نترات الأمونيوم + AM ، و على الرغم من ذلك فقد كان سلوك الكروم فى الموسم الثانى أفضل بدرجة واضحة من الموسم الأول خاصة فى المعاملات المشتملة على (AM) ، بالإضافة إلى أن نتائج تحليل التربة أوضحت أن النيتروجين المتبقى بها كان أفضل فى المعاملات المشتملة على (AM) عند أعلى معدل نيتروجين .

و بناءً على ذلك ، يمكن التوصية بإستخدام اليوريا أو نترات الأمونيوم مضافاً إليهما مثبط النترتة (AM) و ذلك عند معدل (١٠٠ جم نيتروجين / كرمة / سنة) و ذلك للكروم البالغة من الصنف تومسون سيدلس النامية تحت ظروف مشابهة لظروف التجربة و ذلك لتحقيق أفضل إثمار و خصائص للأوراق .