RESULTS AND DISCUSSION

A. Growth characters:

1- Number of stalks/ meter length:

Table (2) shows the combined analysis of plant crop and its first ratoon of number of plants/ meter length as affected by nitrogen sources, application time and N fertilization levels. Data show that number of plants/ meter length was significantly affected by the nitrogen sources at 120 and 150 days, while this effect was not significant at 180 days. The highest number of plants/ meter length, was obtained by using ammonium nitrate, while the lowest number was given by using slow release fertilizer.

The increase was obtained by using ammonium nitrate which may be due to favoured tillering in early stage of growth.

These results are in agreement with those obtained by Dalal and Prasad (1975), Enzeman and Thein (1977), Tishchenko *et al.* (1992) and Kapoor *et al.* (1993).

The differences between the averages of number of stalks/ meter length were not significant at 120 days due to the application time of N, whereas they were significantly affected at 150 and 180 days. Adding N fertilizer at two equal doses, the first was applied after complete germination and the other half at

Table (2): Number of plants/ meter length as affected by nitrogen sources, application times and N levels coated at 120, 150 and 180 days from planting.

Character / Treatments	Number of plants/ meter length		
	At 120 days	At 150 days	At 180 days
A. Nitrogen sources:			
1. Ammonium sulphate	14.8	17.0	15.0
2. Ammonium nitrate	15.3	17.3	15.1
3. Urea	14.4	17.0	14.7
4. Slow release fertilizer	12.3	15.4	13.6
L.S.D 0.05	1.6	1.3	N.S
B. Application time:			
1. B1	14.1	16.2	14.2
2. B2	14.3	17.1	15.0
L.S.D 0.05	N.S	0.9	0.7
C. Nitrogen levels:			
1. Control (without N)	12.4	14.9	13.2
2. 80 kg N/ fed.	14.1	16.5	14.5
3. 160 kg N/ fed.	15.3	17.7	15.6
4. 240 kg N/ fed.	15.1	17.9	15.2
L.S.D 0.05	1.1	1.3	1.1

B1: All amount of nitrogen at planting.

B2: Half of amount of nitrogen after germination (40 days from planting) and the other half after one month later

one month later, gave the highest number of stalk/ meter length.

Adding the N fertilizer in two equal doses resulted in increasing the tillers which might be due to the increase in efficiency of nitrogen and this in turn increases the meristimatic tissues. The result agree with those obtained by Rosenfeld (1959), Narwal and Malik (1981) and Porwal and Kumpawat (1984).

The effect of N fertilizer levels on the number of plants/ meter long of combined analysis for plant crop and its first ratoon at 120, 150 and 180 days of age was significant at all ages due to the N fertilizer. The number of plants/ meter length increased by increasing N levels up to 160 kg N/ fed. This may be due to the fact that plant tillering ability requires more nutrient up to 160 kg N/ fed.

These results are in a good agreement with those obtained by Singh (1973), Tantawi (1979),Kamwar *et al.* (1989), Abd El- Gawad *et al.* (1992 a) and Bangar *et al.* (1993).

The effect of the interaction between nitrogen sources and levels of N at 150 days of age is shown in Table (3).

The highest number of stalks/ meter long of sugar cane was obtained when received 240 kg N/ fed. in a form of ammonium nitrate, whereas the lowest one was obtained by using slow release fertilizer at the same level.

Table (3): Number of plants/ meter length as affected by the interaction between nitrogen sources and levels of N at 150 days from planting.

Treatments	Nitrogen levels (kg N/ fed.)			
	0	80	160	240
Nitrogen sources:				
1. Ammonium sulphate	14.8	17.1	17.3	18.7
2. Ammonium nitrate	14.7	15.4	19.2	19.8
3. Urea	15.0	16.6	18.7	17.6
4. Slow release fertilizer	15.3	16.8	15.6	14.1
L.S.D 0.05	2.6			

2- Plant height:

Data illustrated in Table (4) show the effect of nitrogen sources, application dates and nitrogen levels on plant height for combined analysis of plant crop and its first ratoon crop at 180, 210, and 240 days of age. The plant height was significantly affected by the different nitrogen sources at the three sampling times. The highest values of plant height were obtained by using ammonium nitrate at 180 days age. Whereas this result was with urea at 210 and 240 days age.

Application of ammonium nitrate or urea slightly favoured cane growth in terms of plant height at most sampling dates. The effect of urea was quickly reflected on the plant response of 180 days, which the uptake from ammonium nitrate may be over than urea but the response after a time (210 and 240 days age). The uptake from urea may be over than ammonium nitrate which increased plant height.

Similar results were reported by Dalal and Prasad (1975), Obatolu and Enzeman (1985) and Tishchenko *et al.* (1992).

Data in the same Table show the effect of time of application on plant height. Adding all amount at planting gave the taller plants than those received the half amount after complete germination and the other at one month later. The plant height was significantly affected at 210 days of age, but was not at 180 or 240 days. Adding all the amount of N at planting resulted in giving the best germination which in turn

Table (4): Plant height (cm) as affected by nitrogen sources, application times and N levels coated at 180, 210 and 240 days from planting.

Character Treatments	Plant height (cm)		
	At 180 days	At 210 days	At 240 days
A. Nitrogen sources:			
1. Ammonium sulphate	225.68	243.58	260.77
2. Ammonium nitrate	234.12	244.95	265.54
3. Urea	233.68	250.39	267.06
4. Slow release fertilizer	216.83	234.45	246.75
L.S.D 0.05	8.35	8.67	8.45
B. Application time:			
1. B1	229.57	245.80	260.58
2. B2	225.59	240.89	259.47
L.S.D 0.05	N.S	4.75	N.S
C. Nitrogen levels:			
1. Control (without N)	214.52	227.58	246.08
2. 80 kg N/ fed.	227.52	242.13	258.37
3. 160 kg N/ fed.	230.50	248.37	264.73
4. 240 kg N/ fed.	237.79	255.31	270.94
L.S.D 0.05	5.11	2.56	3.06

B1: All amount of nitrogen at planting.

B2: Half of amount of nitrogen after germination (40 days from planting) and the other half after one month later

followed by tallest plants which resulted from the increasing in meristematic tissues.

Similar results were reported by Rosenfeld (1959), Narwal and Malik (1981) and Porwal and Kumpawat (1984).

Data in the same Table show that plant height was affected by nitrogen levels at 180, 210, and 240 days. There were significant differences at 180, 210, and 240 days.

The plant height increased as nitrogen levels increased up to 240 kg N/ fed. Nitrogen fertilizer encouraged division of plant cells and differentiation of the meristematic tissues especially during the growth stage of plant.

The results are in harmony with those obtained by Singh (1973), Tantawi (1979), Rana and Saini (1989 a), Prasad *et al.* (1991) and Bangar *et al.* (1992), while Bahard *et al.* (1991) showed that increasing N had no effect.

Table (5) shows the averages of plant height as affected by the interaction between nitrogen sources and nitrogen levels at 210 days age. The highest values of plant height were obtained by using urea at 240 kg N/ fed.

The interaction between the nitrogen sources and N application time on plant height is shown in Table (6). Fertilization sugar cane by 240 kg N/ fed. once at planting gave the highest plant height at 210 days age.

Table (5): Plant height (cm) as affected by the interaction between nitrogen sources and N levels at 210 days from planting.

Treatments	Nitrogen levels (kg/ fed.)			
	0	80	160	240
Nitrogen sources:				
1. Ammonium sulphate	230.33	241.50	246.80	255.66
2. Ammonium nitrate	225.50	244.41	253.25	256.66
3. Urea	238.66	248.58	253.70	260.58
4. Slow release fertilizer	215.83	234.00	239.66	248.33
L.S.D 0.05	5.12			

Table (6): Plant height (cm) as affected by the interaction between application time and N levels at 210 days of age.

Character / Treatments	Plant height (cm)	
	B1	B2
Nitrogen levels:		
1. Control (without N)	232.62	222.54
2. 80 kg N/ fed.	244.08	240.16
3. 160 kg N/ fed.	250.25	246.50
4. 240 kg N/ fed.	256.25	254.37
L.S.D. 0.05	5.12	

B1: All amount of nitrogen at planting.

B2: Half of amount of nitrogen after germination (40 days from planting) and the other half after one month later.

B. Yield and yield components:

1. Millable cane length:

Table (7) show that the differences between four nitrogen sources on millable cane length. Slow release fertilizer was superior to ammonium sulphate, ammonium nitrate and urea. This result may be due to using slow release fertilizer slightly favoured cane growth in terms of stalk length at most sampling dates.

These results are in good agreement with those of Enzeman and Thein (1977), Obatolu and Enzeman (1985), Tishchenko *et al.* (1992) and Kapoor *et al.* (1993).

Stalk length was significantly affected by the time of nitrogen fertilization application. Data presented in Table (7) demonstrate that applying N to sugar cane in two equal doses, half of amount of nitrogen after complete germination and the other half at one month later (B2) was superior for stalk length than that of one dose, all amount of nitrogen at planting (B1).

This result might be due to the strong root of cane which absorbed more N in B2 than B1.

These results are in good agreement with those obtained by Rosenfeld (1959), Porwal and Kumpawat (1984), Iznaga *et al.* (1988) and Jayabal and Chockalingam (1990 a and b).

Table (7): Some yield component characters as affected by nitrogen sources, application times and N levels.

Treatments / Character	Millables cane length (cm)	Stalk diameter (cm)	Number of internodes per stalk	Stalk weight (kg)
A. Nitrogen sources:				
1. Ammonium sulphate	261.8	2.6	17.7	1.360
2. Ammonium nitrate	263.0	2.7	18.3	1.397
3. Urea	266.0	2.7	18.3	1.432
4. Slow release fertilizer	277.5	2.7	17.3	1.320
L.S.D. 0.05	N.S	N.S	0.3	N.S
B. Application time:				
1. B1	259.5	2.7	17.9	1.365
2. B2	264.7	2.7	17.9	1.389
L.S.D. 0.05	3.6	N.S	N.s	N.S
C. Nitrogen levels:				
1. Control (without N)	248.5	2.6	17.4	1.231
2. 80 kg N/ fed.	262.0	2.7	17.7	1.357
3. 160 kg N/ fed.	269.2	2.7	18.1	1.413
4. 240 kg N/ fed.	268.6	2.7	18.5	1.507
L.S.D. 0.05	4.1	N.S	0.3	N.S

B1: All amount of nitrogen at planting.

B2: Half of amount of nitrogen after germination (40 days from planting) and the other half after one month later.

Stalk length data as affected by nitrogen fertilizer levels are show in the same Table. The levels of nitrogen fertilization had significant effect on the stalk length at harvesting. There were successive and significant increase in the trait as nitrogen levels increased up to 160 kg N/ fed.

This increase in stalk length may be due to high N levels which encouraged the growth of sugar cane plant and subsequently the length was increased.

These results are in full agreement with those of Tantawi (1979), Taha *et al.* (1986), Kanwar *et al.* (1989), Yaduvanshi *et al.* (1990), Bangar *et al.* (1992) and Sondge *et al.* (1992).

The effect of the interaction between nitrogen sources and levels on stalk length was given in Table (8). The highest stalk length was obtained with fertilization sugar cane by urea at level of 160 kg N/ fed.

Table (9) show the interaction between time of application and levels of nitrogen fertilization. The tallest plants were resulted from adding 240 kg N/ fed. in two equal doses.

2. Stalk diameter:

Data of stalk diameter at harvesting as affected by nitrogen levels are shown in Table (7). Data show that stalk diameter was insignificantly affected by nitrogen sources.

Table (8): Millable cane length (cm) as affected by the interaction between nitrogen sources and levels.

Treatments	Nitrogen levels (kg/ fed.)			
	0	80	160	240
<u>Nitrogen sources:</u>				
1. Ammonium sulphate	252.3	259.3	265.4	270.1
2. Ammonium nitrate	249.7	262.3	272.4	267.8
3. Urea	256.7	263.8	272.6	270.7
4. Slow release fertilizer	235.3	262.7	266.4	265.7
L.S.D. 0.05	8.2			

Table (9): Millable cane length (cm) and number of internodes per stalk as affected by the interaction between application time of nitrogen and levels.

Characters / Treatments	Millable cane length		Number of internodes/ stalk	
	B1	B2	B1	B2
Nitrogen levels:				
1. Control (without N)	249.4	247.6	17.7	17.1
2. 80 kg N/ fed.	260.0	264.0	17.5	17.8
3. 160 kg N/ fed.	263.5	294.7	18.0	18.2
4. 240 kg N/ fed.	265.0	272.3	18.5	18.5
L.S.D. 0.05	5.8		0.5	

B1: All amount of nitrogen at planting.

B2: Half of amount of nitrogen after germination (40 days from planting) and the other half after one month later.

These results are in accordance with Enzeman and Thein (1977), Tishchenko *et al.* (1992) and Kapoor *et al.* (1993).

Data in the same Table show the average of stalk diameter under different times of application. There were no differences in stalk diameter values between the two times of application.

These results are in agreement with those of Narwal and Malik (1981), Porwal and Kumpawat (1984) and Jayabal and Chockalingam (1990 a).

Table (7) shows that the effect of nitrogen levels on stalk diameter was not affected significantly by nitrogen levels.

These results are in harmony with those obtained by several workers such as Singh (1973), Singh (1974), Narwal and Malik (1981), Kanwar *et al.* (1989), Rana and Saini (1989 a), and Abd El- Gawad *et al.* (1992 b).

3- Number of internodes/ stalk.

Results in Table (7) revealed that nitrogen sources had significant differences on number of internodes per stalk. Fertilization sugar cane by ammonium nitrate or urea tended to produce more internodes than slow release fertilizer or ammonium sulphate.

Both ammonium nitrate and urea favoured the growth of plant cane which gave the tallest plants and more internodes per stalk when compared with the other treatments.

Similar results were reported by Singh and Singh (1973), Eastwood (1976), Munoz and Molina (1982), Anon (1988) and Kadam *et al.* (1991).

Number of internodes/ stalk did not differ by the time of nitrogen fertilization.

Data in the same Table show that there was a relationship between nitrogen levels and number of internodes/ stalk up to 240 kg N/ fed. The number of internodes/ stalk was increased with level of 240 kg N/ fed. by 6.3, 4.5 and 2.2 % comparing by zero, 80 and 160 Kg N/ fed, respectively.

Increasing number of internodes by nitrogen fertilization owing to the effect of those elements in stimulating cell division and cell elongation with plant tissues through the increment in nitrogen absorption.

These results are in agreement with those of Singh and Tiwari (1972), Abdel- Latif (1980), Faria *et al.* (1983), Durai *et al.* (1989), Coulibaly (1990) and Singh *et al.* (1990).

Table (9) show the interaction effect between application time and levels of nitrogen fertilization on number of internodes per stalk. The highest number of internodes per stalk obtained from the treatment of 240 kg N/ fed. which was applied at two equal doses or one dose.

4. Stalk weight (kg):

The effect of nitrogen sources, time of application and levels of nitrogen fertilization on the average values of combined analysis of plant crop and its first ratoon crop for stalk weight (kg), is illustrated in Table (7). Data revealed that stalk weight was not significantly affected by nitrogen sources. While fertilization sugar cane by using urea gave the heavier plants. Urea superior to ammonium nitrate, ammonium sulphate and slow release fertilizer by 2.50, 5.29 and 8.48 %, respectively. Using urea for sugar cane fertilization favoured the growth and nitrogen uptake which gave the highest stalk weight.

These results are in accordance with those obtained by Dalal and Prasad (1975), Mounz and Molina (1982), Obatolu and Enzeman (1985) and Banger and Sharma (1992).

Data in the same Table show the effect of time of application on stalk weight. Stalk weight was not significantly affected by the time of application. Adding nitrogen fertilization in two equal doses gave the highest value of stalk weight.

These results are in good line with those obtained by Hamissa *et al.* (1974), Iznaga *et al.* (1988) and Durai *et al.* (1989).

Stalk weight was not affected significantly by the nitrogen levels (Table 7). Increasing nitrogen levels up to 240 kg N/ fed. resulted in a marked increase in stalk weight.

The differences among nitrogen levels in values of stalk weight might have resulted from the increase in length, diameter, number of internodes and leaf area.

Similar results were reported by Singh and Tiwari (1972), Abdel- Latif (1980), Yadav and Sharma (1983), El- Bashbishy *et al.* (1988 a).

5. Weight of juice in kg/ stalk:

The effects of nitrogen sources, time of application and levels on juice weight/ stalk are shown in Table (10). Ammonium nitrate as nitrogen source gave the highest weight of juice when compared with the other sources. Ammonium nitrate was superior than urea, ammonium sulphate and slow release fertilizer by 1.01, 10.48 and 15.08 %, respectively. The increase in juice weight resulted from using ammonium nitrate, might be due to the nitrogen in this source in the forms nitrate $No3^-$ and ammonium $NH4^+$.$No3^-$ is not adsorb in the soil and this in turn will be available for plant. These results were observed by Eastwood (1976), Munoz and Molina (1982), Faria *et al.* (1983), Fearon (1988), Iznaga *et al.* (1988), and Bangar and Sharma (1992).

The time of nitrogen application was significantly affected the juice weight per stalk, while fertilization sugar cane by two equal doses gave the higher averages of juice than that received one dose at planting.

This increase due to the application of nitrogen after germination was more available than that obtained at planting time. These results are in good agreement with those of Porwal

Table (10): Juice weight/ stalk (kg) and sugar yield (ton/ fed.) as affected by nitrogen sources, application times and levels.

Character Treatments	Juice weight per stalk (kg)	Sugar yield (ton/ fed.)
A. Nitrogen sources:		
1. Ammonium sulphate	0.725	6.314
2. Ammonium nitrate	0.801	6.134
3. Urea	0.793	6.259
4. Slow release fertilizer	0.696	6.667
L.S.D. 0.05	N.S	N.S
B. Application time:		
1. B1	0.750	6.034
2. B2	0.758	6.653
L.S.D 0.05	N.S	6.183
C. Nitrogen levels:		
1. Control (without N)	0.693	4.481
2. 80 kg N/ fed.	0.756	6.134
3. 160 kg N/ fed.	0.747	7.333
4. 240 kg N/ fed.	0.820	7.388
L.S.D. 0.05	N.S	0.243

B1: All amount of nitrogen at planting.

B2: Half of amount of nitrogen after germination (40 days from planting) and the other half after one month later.

and Kumpawat (1984), Iznaga *et al.* (1988) and Durai *et al.* (1989).

Nitrogen fertilization levels had not significant differences on juice weight/ stalk (Table 10). There was successive increase in cane juice as nitrogen levels increased up to 240 kg N/ fed. These results may be due to the favourable effect of nitrogen on the vegetative growth stage of plants and particularly to the photosynthesis of sugar and other carbohydrate in the leaf.

These results are in a good agreement with those obtained by Singh (1973), Thakur *et al.* (1981), Faria *et al.* (1983), El-Bashbishy *et al.* (1988 b), Jayabal and Chockalingam (1990 b), Singh *et al.* (1990) and Thomas and Scott (1990).

6. Cane yield (ton/ fed.):

The analysis of variance of the three studied factors: nitrogen sources, application times and N levels of plant crop and its first ratoon and combined analysis are presented in Table (11).

The cane yield was significantly affected by nitrogen sources of plant crop in (1991/ 1992) and combined analysis but was not in the first ratoon crop in (1992/ 1993). Slow release fertilizer gave the highest cane yield, while the lowest cane yield was obtained by using ammonium sulphate. The amount of nitrogen which was uptaked by cane plants was higher with slow release fertilizer superior the other sources. This because N can

Table (11): Net cane yield (ton/ fed.) as affected by nitrogen sources, application times and N levels.

Seasons / Treatments	Yield (ton/ fed.)		
	1991/1992	1992/ 1993	Combined
A. Nitrogen sources:			
1. Ammonium sulphate	48.806	42.192	45.499
2. Ammonium nitrate	51.567	41.171	46.369
3. Urea	51.502	40.356	45.929
4. Slow release fertilizer	54.608	45.306	49.959
L.S.D. 0.05	1.937	N.S	2.364
B. Application time:			
1. B1	50.034	39.325	44.680
2. B2	53.207	45.188	49.197
L.S.D 0.05	1.486	2.889	1.491
C. Nitrogen levels:			
1. Control (without N)	36.448	30.294	33.371
2. 80 kg N/ fed.	52.115	41.490	46.802
3. 160 kg N/ fed.	58.452	48.046	53.249
4. 240 kg N/ fed.	59.469	49.196	54.332
L.S.D 0.05	1.915	2.101	1.400

B1: All amount of nitrogen at planting.

B2: Half of amount of nitrogen after germination (40 days from planting) and the other half after one month later.

be available for long time for plants in case of slow release fertilizer.

These results agree with those obtained by Singh and Singh (1973), Enzeman and Thein (1977), Munoz and Molina (1982), Anon (1988), Fearon (1988) and Weng and Chan (1991).

The cane yield was significantly affected due to the time of nitrogen application. Adding nitrogen fertilizer in two equal doses gave the higher yield than that obtained when adding the all amount in one dose. This result was clear in plant crop, first ratoon and their combined analysis for two seasons.

These results are in good agreement with those obtained by Hamissa *et al.* (1974), Porwal and Kumpawat (1984) and Durai *et al.* (1989).

Nitrogen levels had significant differences between the averages of cane yield of the plant crop, first ratoon and combined analysis. There were successive increase in the cane yield as nitrogen level was increased up to 160 kg N/ fed. However, the differences between the averages of cane yield which received 160 and 240 kg N/ fed. was not significant.

These results may be due to the favourable effect of N on the vegetative growth of cane plants and its encourage for tillering capacity.

These results are in agreement with those of Parihar (1971), Ingram (1982), Tantawi (1979), Faria *et al.* (1983), Yadav and Sharma (1983), Chavan *et al.* (1985), Gascho *et al.* (1986), Ng Kee Kwong and Deville (1989), Jaybal and Chockalingam (1990b), Singh *et al.* (1990), Baharad *et al.* (1991), and Dantur *et al.* (1992). While, Devi *et al.* (1990) showed that increasing N levels did not increase cane yield due to the already high N of the soil.

Data in Table (12) show that the interaction between nitrogen sources and nitrogen levels which affected significantly cane yield. The highest cane yield was obtained from using slow release fertilizer as nitrogen source with 160 kg N/ fed. However, the lowest cane yield was obtained from using ammonium sulphate with zero N level.

The interaction effect between the three studied factors on cane yield is shown in Table (13). The highest cane yield was obtained from adding slow release fertilizer at 240 kg N/ fed. at two equal doses. The lowest cane yield obtained when using ammonium sulphate equal to zero kg N/ fed. at one dose at planting.

7. Sugar yield (ton/ fed.):

Differences among nitrogen sources on sugar yield (ton/ fed.) were not significant. However, application of slow release fertilizer resulted in higher sugar yield than the other sources. This increase may be due to the increase in sugar recovery % accompanied its application (Table 10). These results are in

Table (12): Cane yield (ton/ fed.) as affected by the interaction between nitrogen sources and levels.

Treatments	Nitrogen levels (kg/ fed.)			
	0	80	160	240
Nitrogen sources:				
1. Ammonium sulphate	32.492	46.846	50.025	52.633
2. Ammonium nitrate	34.508	46.042	52.683	52.242
3. Urea	32.717	43.850	52.363	54.788
4. Slow release fertilizer	33.767	50.471	57.925	57.667
L.S.D 0.05	2.8			

Table (13): Net cane yield (ton/ fed.) as affected by the interaction between nitrogen sources, application times and N levels.

Treatments		1991/ 1992				Combined			
		N levels (kg/ fed.)				N levels (kg/ fed.)			
		0	80	160	240	0	80	160	240
Nitrogen sources:	Application time:								
1. Ammonium sulphate	B1	31.550	47.567	59.133	55.200	30.925	44.200	47.917	48.833
	B2	34.967	51.033	56.333	59.667	34.058	49.492	52.133	56.433
2. Ammonium nitrate	B1	37.917	49.800	53.500	59.817	34.208	41.642	48.333	50.733
	B2	37.733	54.333	61.100	59.333	34.808	50.442	57.033	53.750
3. Urea	B1	35.817	49.000	57.783	59.817	31.617	39.783	50.825	53.533
	B2	35.150	51.967	60.167	62.317	33.817	47.917	53.900	56.042
4. Slow release fertilizer	B1	32.583	54.917	61.917	60.233	28.775	47.983	58.083	56.483
	B2	46.867	58.300	62.683	59.367	38.758	51.958	57.761	58.850
L.S.D 0.05		5.416				3.960			

B1: All amount of nitrogen at planting.

B2: Half of amount of nitrogen after germination (40 days from planting) and the other half after one month later.

accordance with those of Dalal and Prasad (1975), Obatolu and Enzeman (1985) and Windiharto and Soepardi (1991).

Sugar yield was significantly affected by nitrogen application time. Two equal doses from nitrogen fertilization increased sugar yield than one dose. This increase in cane yield which reflecting in providing more carbohydrate for plant resulted in increasing the sugar yield.

These results are in a good agreement with those obtained by Sugumaran *et al.* (1976), Durai *et al.* (1989) and Macalintal and Urgel (1990).

The averages of sugar yield as affected by nitrogen levels are given in Table (10). Sugar yield significantly increased by increasing the N level. The differences between the level of nitrogen equal to 240 kg N/ fed. and the other levels were not significant for sugar yield. These results gave the same trend which were obtained by El- Bashbishy *et al.* (1988), Abd El-Gawad *et al.* (1991 b), Bangar *et al.* (1992), and Dantur *et al.* (1992).

Table (14) show the interaction effect between nitrogen sources and levels on sugar yield. The highest sugar yield was obtained by using slow release fertilizer at 160 kg N/ fed. while the lowest one was obtained from the control treatment.

Table (14): Sugar yield (ton/ fed.) as affected by the interaction between nitrogen sources and levels.

Treatments	Nitrogen levels (kg/ fed.)			
	0	80	160	240
Nitrogen sources:				
1. Ammonium sulphate	4.525	4.499	6.889	7.344
2. Ammonium nitrate	4.387	5.923	7.070	6.958
3. Urea	4.398	5.651	7.408	7.578
4. Slow release fertilizer	4.412	6.625	7.964	7.670
L.S.D 0.05	0.487			

The interaction between the three studied factors was given in Table (15). Data show that the highest sugar yield obtained by using slow release fertilizer at 160 kg N/ fed. in one dose.

C: Juice characteristics:

1- Total soluble solids percentage (T.S.S):

Data presented in Table (16) show the averages of total soluble solids percentage measured at 9, 10 and 11 months as affected by N sources, time of application and levels.

Total soluble solids was significantly affected by nitrogen sources at 9 and 10 monthes but was not at 11 monthes.

The highest total soluble solids was obtained by using urea applied at 9 and 10 months, while slow release fertilizer gave the highest total soluble solids at 11 months.

These results in a good agreement with those of Singh and Singh (1973), Obatolu and Enzeman (1985) and Sharma and Gupta (1990).

The total soluble solids was not significantly affected by N application time at 9, 10 or 11 monthes. Adding all amount of nitrogen at planting time gave the highest total soluble solids during growth stage.

These results are supported by Hamissa *et al.* (1974), Narwal and Malik (1981) and Macalintal and Urgel (1990).

Table (15): Sugar yield (ton/ fed.) as affected by the interaction between nitrogen sources, application times and N levels.

Treatments		N levels (kg/ fed.)			
		0	80	160	240
Nitrogen sources:	Application time:				
1. Ammonium sulphate	B1	4.482	6.059	6.680	6.769
	B2	4.562	6.939	7.099	7.919
2. Ammonium nitrate	B1	4.328	5.314	6.514	6.874
	B2	4.846	6.531	7.625	7.043
3. Urea	B1	4.335	4.999	7.059	7.531
	B2	4.462	6.302	7.758	7.625
4. Slow release fertilizer	B1	3.499	6.705	8.204	7.195
	B2	5.325	6.546	7.723	8.144
L.S.D 0.05		0.689			

B1: All amount of nitrogen at planting.

B2: Half of amount of nitrogen after germination (40 days from planting) and the other half after one month later.

Table (16): Total soluble solids as affected by nitrogen sources, application times and N levels at 9, 10 and 11 monthes from planting.

Plant age / Treatments	At 9 months	At 10 months	At 11 months
A. Nitrogen sources:			
1. Ammonium sulphate	19.54	19.62	19.91
2. Ammonium nitrate	19.56	19.85	19.90
3. Urea	19.80	19.90	19.92
4. Slow release fertilizer	19.60	19.70	20.00
L.S.D 0.05	0.27	0.25	N.S
B. Application time:			
1. B1	19.70	19.80	19.90
2. B2	19.61	19.71	19.80
L.S.D 0.05	N.S	N.S	N.S
C. Nitrogen levels:			
1. Control (without N)	19.45	19.70	20.00
2. 80 kg N/ fed.	19.52	19.75	19.70
3. 160 kg N/ fed.	19.65	19.78	19.70
4. 240 kg N/ fed.	19.75	19.82	20.00
L.S.D 0.05	N.S	N.S	0.28

B1: All amount of nitrogen at planting.

B2: Half of amount of nitrogen after germination (40 days from planting) and the other half after one month later.

Data in the same Table show the effect of nitrogen levels on total soluble solids. Total soluble solids increased when nitrogen levels increased but this increase in total soluble solids did not reach the level of significance except at 11 month sampling date.

These results are similar to those obtained by Abdel- Latif (1980), Faria *et al.* (1983), Abd El- Gawad *et al.* (1991 c), Banwari Lal (1992) and Tamilselvan and Jayabal (1993).

Data presented in Table (17) show the interaction effect between nitrogen sources and the time of application on total soluble percentage. The highest value of this trait was obtained by using urea added at one or two doses. The same was with ammonium nitrate added once at planting time for 9 months sample, while the highest average of total soluble solids was obtained by ammonium sulphate or urea when received all amounts at planting time or slow release fertilizer at two equal doses at 10 month age.

Table (18) show the interaction effect between nitrogen sources and nitrogen levels on total soluble solids. The lowest value of total soluble solids was obtained by using slow release fertilizer at 160 kg N/ fed.

The interaction effect between the three factors under study on total soluble solids is shown in Table (19). Fertilization of sugar cane by 80 kg N/ fed. of urea when added at planting time gave the highest value as compared with control.

Table (17): Total soluble solids as affected by the interaction between nitrogen sources and application times at 9 and 10 monthes from planting.

Plant age / Treatments	At 9 monthes		At 10 monthes	
	B1	B2	B1	B2
Nitrogen sources:				
1. Ammonium sulphate	19.4	19.1	20.0	19.6
2. Ammonium nitrate	19.8	19.3	19.9	19.9
3. Urea	19.8	19.8	20.0	19.9
4. Slow release fertilizer	19.6	19.5	19.6	20.0
L.S.D 0.05	0.3		0.4	

B1: All amount of nitrogen at planting.

B2: Half of amount of nitrogen after germination (40 days from planting) and the other half after one month later.

Table (18): Total soluble solids as affected by the interaction between nitrogen sources and levels at 11 monthes from planting.

Treatments	Nitrogen levels (kg/ fed.)			
	0	80	160	240
Nitrogen sources:				
1. Ammonium sulphate	20.2	19.6	20.1	19.8
2. Ammonium nitrate	19.7	20.0	19.4	20.0
3. Urea	20.1	19.9	19.4	19.4
4. Slow release fertilizer	20.2	19.5	19.2	19.4
L.S.D 0.05	0.6			

Table (19): Total soluble solids as affected by the interaction between nitrogen sources, application times and N levels at 11 monthes from planting..

Treatments		N levels (kg/ fed.)			
		0	80	160	240
Nitrogen sources:	Application time:				
1. Ammonium sulphate	B1	19.0	19.4	20.0	19.8
	B2	19.2	19.7	20.1	19.8
2. Ammonium nitrate	B1	19.1	20.2	19.4	20.1
	B2	19.3	19.7	19.3	19.9
3. Urea	B1	18.9	20.4	19.3	19.0
	B2	19.2	19.4	19.6	19.9
4. Slow release fertilizer	B1	19.1	20.1	19.4	19.9
	B2	18.2	18.9	18.9	19.9
L.S.D 0.05		0.8			

B1: All amount of nitrogen at planting.

B2: Half of amount of nitrogen after germination (40 days from planting) and the other half after one month later.

Averages of total soluble solids (at harvest) as affected by nitrogen sources are given in Table (20). The total soluble solids was not significantly affected by nitrogen sources. Slow release fertilizer gave a higher average than the other sources. The increasing in total soluble solids by using slow release fertilizer might be due to the more available nitrogen released from this fertilizer for long time when compared with the other N sources under study. These results are in the same line with those obtained by Singh and Singh (1973), Obatolu and Enzeman (1985), Sharma and Gupta (1991), and Kapoor *et al.* (1993).

It is clear from the data presented in Table (20) that the highest total soluble solids was resulted from fertilizing sugar cane in two equal doses when compared with one dose. The total soluble solids increased by 0.46 % over the control.

Fertilization sugar cane in one dose at planting resulted in decreasing the nitrogen uptake than two doses. Similar results are found by Shrinivasan *et al.* (1973), and Kapoor *et al.* (1993).

Data in the same Table show the effect of nitrogen levels on total soluble solids. It is clear from the data presented that this trait increased progressively with the increase in nitrogen levels but not reach the level of significance. Treatments of 240

Table (20): Juice characters as affected by nitrogen sources, application times and levels.

Characters / Treatments	Total soluble solids	Sucrose percentage	Purity percentage	Reducing sugar
A. Nitrogen sources:				
1. Ammonium sulphate	20.23	19.34	95.61	0.17
2. Ammonium nitrate	20.48	18.65	85.61	0.19
3. Urea	20.31	19.06	93.87	0.17
4. Slow release fertilizer	20.95	18.91	90.05	0.19
L.S.D 0.05	N.S	N.S	5.63	N.S
B. Application time:				
1. B1	20.44	18.94	98.84	0.17
2. B2	20.55	19.04	91.73	0.19
L.S.D 0.05	N.S	N.S	N.S	N.S
C. Nitrogen levels:				
1. Control (without N)	20.07	17.96	84.48	0.18
2. 80 kg N/ fed.	20.39	18.67	91.56	0.17
3. 160 kg N/ fed.	20.48	19.23	93.89	0.18
4. 240 kg N/ fed.	20.53	19.16	93.03	0.19
L.S.D. 0.05	N.S	0.32	N.S	N.S

B1: All amount of nitrogen at planting.

B2: Half of amount of nitrogen after germination (40 days from planting) and the other half after one month later

kg N/ fed. gave the highest total soluble solids when compared with the other levels under study.

The increase in total soluble solids resulted from increasing the uptaking of nitrogen which in turn gave a large leaf area and photosynthesis which lead to more accumulation of carbohydrate.

The results are in a good agreement with those obtained by Narwal and Malik (1981), Taha *et al.* (1986), Sharma and Gupta (1990), Rana and Saini (1989 b), Abd El- Gawad *et al.* (1992 c) and Lal (1992).

2. Sucrose percentage:

Data presented in Table (20) show the effect of nitrogen sources on sucrose percentage in cane juice. The sucrose percentage was not significantly affected by nitrogen sources. Ammonium sulphate gave the highest sucrose percentage than other sources. It may be due to the fertilizer is consisted of nitrogen and sulphate. These results are in good agrement with those obtained by Dalal and Prasad (1975), Obatolu and Enzeman (1985), Sharma and Gupta (1991) and Kapoor *et al.* (1993).

Data in the same table show that sucrose percentage was not significantly affected due to the time of nitrogen application. While adding N in two equal doses resulted in increasing sucrose percentage when compared with one dose. Similar results were observed by Hamissa *et al.* (1974), Narwal and Malik (1981), Jayabal and Chockalingam (1990a) and Macalintal and Urgel (1990).

The averages of juice quality parameter (sucrose percentage) as affected by nitrogen levels are given in Table (20). Sucrose percentage increased when nitrogen level increased up to 160 kg N/ fed. This might be due to the increase in nitrogen uptake which raise T.S.S and this in turn resulted in increasing sucrose percentage. These results are in good agreement with those obtained by Narwal and Malik (1981), Faria *et al.* (1983), Yaduvanshi *et al.* (1990) Rana and Saini (1989 b), and Banwari Lal (1992).

Data in Table (21) show the interaction effect between N sources and time of N application on sucrose percentage. The highest sucrose percentage was obtained by fertilization sugar cane by ammonium sulphate in one dose.

It is clear from the data presented in Table (22) that the interaction between nitrogen sources, application time and levels of nitrogen had significant effect on sucrose percentage. The highest value of sucrose percentage was obtained by using urea in two doses at level of 240 kg N/ fed.

3. Purity percentage:

Results in Table (20) show the significant differences among the averages of purity percentage as affected by nitrogen

Table (21): Sucrose percentage as affected by the interaction between nitrogen sources and application time of N.

Treatments	Application time	
	B1	B2
Nitrogen sources:		
1. Ammonium sulphate	19.49	19.19
2. Ammonium nitrate	18.47	18.84
3. Urea	19.02	19.10
4. Slow release fertilizer	18.77	19.03
L.S.D. 0.05	0.34	

B1: All amount of nitrogen at planting.

B2: Half of amount of nitrogen after germination (40 days from planting) and the other half after one month later.

Table (22): Sucrose percentage as affected by the interaction between nitrogen sources, application times and N levels.

Treatments		N levels (kg/ fed.)			
		0	80	160	240
Nitrogen sources:	Application time:				
1. Ammonium sulphate	B1	19.05	19.21	19.46	19.24
	B2	18.9	19.40	19.08	19.40
2. Ammonium nitrate	B1	17.97	18.06	18.81	19.03
	B2	19.47	18.46	18.80	18.63
3. Urea	B1	19.21	18.04	19.20	19.64
	B2	18.73	18.66	19.92	19.09
4. Slow release fertilizer	B1	17.90	19.37	19.59	18.25
	B2	19.46	18.15	18.98	19.54
L.S.D. 0.05		0.90			

B1: All amount of nitrogen at planting.

B2: Half of amount of nitrogen after germination (40 days from planting) and the other half after one month later.

sources. Ammonium sulphate improved purity of cane juice when compared with ammonium nitrate, urea and slow release fertilizer.

The increase in purity by using ammonium sulphate as nitrogen source due to the effect of ammonium sulphate which resulted in increasing sucrose percentage. The time of nitrogen application did not give a significant effect on purity percentage. The fertilized sugar cane in two equal doses of N gave an increase in purity percentage when compared with one dose. Similar results were obtained by those of Sugumaran *et al.* (1976), Sharma and Gupta (1990), and Macalintal and Urgel (1991). Nitrogen levels did not give a significant effect on purity %. There were positive effect between purity % and nitrogen levels up to 160 kg N/ fed. Such effect might be due to the positive effect of high N levels on sucrose percentage as mentioned before.

These results are in accordance with those obtained by Abdel- Latif (1980), Faria *et al.* (1983), Yaduvanshi *et al.* (1990), Rana and Saini (1989 b), Bangar *et al.* (1993) and Banwari Lal (1992).

4. Reducing sugars:

Data in Table (20) show the effect of nitrogen sources, time of application and levels of N on reducing sugar. Nitrogen sources had no significant effect on reducing sugar, whereas ammonium nitrate and slow release fertilizer gave the highest value.

These results are in a good agreement with those obtained by Dalal and Prasad (1975) and Sharma and Gupta (1991).

The effect of nitrogen application time on reducing sugar date illustrated that reducing sugar was not significantly affected by nitrogen application time, while fertilization in two equal doses gave the highest reducing sugars.

Similar results were obtained by Hamissa *et al.* (1974), Durai *et al.* (1989) and Sharma and Gupta (1991). The averages of reducing sugar as affected by nitrogen levels are given in Table (20). Reducing sugars were not affected by nitrogen levels but nitrogen levels showed no harmful effect on reducing sugars. The reduction in reducing sugars resulted from the increase in sucrose and total soluble solids which lead to decrease reducing sugar

These results are in a good agreement with those observed by Narwal and Malik (1981), Taha *et al.* (1986), Rana and Saini (1989 b), Abd El- Gawad *et al.* (1992 c), Banwari Lal (1992) and Tamilselvan and Jayabal (1993).