RESULTS AND DISCUSSIONS

IV-RESULTS AND DISCUSSION

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1- Soil properties:-

1.1. Effect of preceding summer crops on some physical and chemical properties of the soil:

The data in Table (3) show that effect of preceding summer crops on porosity percentage as physical property, and nitrogen, phosphorus, potassium, organic matter percentage as well as pH value as chemical properties of the soil: during 1997/98 and 1998/99 seasons.

1. 1. 1 Porosity:

The results indicated that there were differences in porosity percentage of the soil due to the preceding summer crops in both seasons. The highest porosity percentage (41.40 and 42.60%) was recorded after cowpea in the first and the second seasons, respectively, whereas, the lowest percentage (36.46 and 37.50%) was after maize. The porosity after sorghum (38.4 and 39.10% was higher than that after sunflower (37.40 and 38.80%) which surpassed that after maize.

Generally, the soil porosity could be arranged in descending order according to preceding crops as follows; cowpea, sorghum, sunflower and maize.

It could be concluded that cowpea as a preceding crop increased the porosity percentage of the soil and that maize, sorghum and sunflower favourably affected soil porosity as

Table (3): Effect of preceding summer crops on porosity, total nitrogen (N), total phosphorus (P), total potassium (K) and total organic mater (O.M) percentage and pH value of the soil during 1997/98 and 1998/99 seasons.

Preceding crops	Porosity %		Total N %		Total P %		Total K %		Total OM %		PH	
	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season
Cowpea	41.40	42.60	0.106	0.110	0.232	0.228	1.810	1.825	2.309	2.294	8.30	8.27
Maize	36.46	37.50	0.084	0.092	0.192	0.196	1.805	1.790	2.483	2.460	8.23	8.21
Sorghum	38.4	39.10	0.088	0.090	0.232	0.236	1.855	1.850	2.581	2.528	8.28	8.25
Sunflower	37.40	38.80	0.090	0.098	0.208	0.216	1.850	1.840	2.286	2.279	8.33	8.30
Before seeding summer crops	36.10	36.70	0.080	0.086	0.164	0.172	1.600	1.750	1.893	2.044	8.21	8.19

compared with before seeding summer crops treatment. The good effect of cowpea on soil porosity is mainly due to the narrow C/N ratio of the cowpea root residues, which contributes to quick decomposition of it by soil microorganisms resulting in an increase in the soil porosity.

These results are in agreement with those obtained by Mohamed (1994) who concluded that soil porosity was affected by preceding crops.

1. 1. 2. Total nitrogen:

Results in Table (3) also, showed that there were considerable differences in the total N content in the soil which was determined after harvesting the summer preceding crops in the two seasons of 1997/98 and 1998/99.

In the first season, the highest nitrogen percentage was recorded after cowpea (0.106%) followed by that after sorghum and sunflower (0.088 and 0.090% respectively), and the lowest value (0.084%) was after maize.

In the second season, the highest nitrogen percentage was recorded after cowpea (0.110%) followed by that after sunflower (0.098%), and maize and sorghum gave the lowest value (0.092 and 0.090% respectively) of N content in the soil.

It could be concluded that total nitrogen content of the soil was affected by preceding summer crops, and that legume crop was superior to nonlegumes in increasing nitrogen content of the soil. Cowpea and sunflower sorghum and maize favourably affected

N content of the soil in comparison with the check (nitrogen content in the soil before seeding summer crops treatment).

The good effect of cowpea on nitrogen content of the soil is mainly due to the low ratio of C/N in the residues of cowpea which encouraged the decomposition of such residues contributing to the increase in humus and nitrogen content of the soil.

The effect of maize and sorghum as preceding crops on nitrogen content of the soil was inferior. This may be due to the wide ratio of C/N in their residues. The decomposition of these residues by soil micro-organisms requires additional amounts of nitrogen which is extracted from the soil. This contributes to the reduction in N content of the soil after maize and sorghum.

Similar results were obtained by Urano *et. al.,* (1960) Mannan (1962) Kharabarova (1967), EL-Debaby (1971) EL-Debaby *et. al.,*(1984), Allam (1988), Mohamed (1994) and, Maareg and Allam (1999). They reported that legume crops enriched the soil of the following crop with nitrogen, whereas non legume crops caused a marked consumption of nitrogen content of the soil. On the other hand, Bashir (1980) and Meahasen (1990) found that nitrogen content of the soil was not significantly affected by preceding crops.

1. 1. 3. Total phosphorus:

Phosphorus percentage in the soil considerably differed according to preceding summer crops as shown in Table (3).

In the first season, the highest total phosphorus percentage was recorded after sorghum and cowpea (0.116%), whereas the lowest value (0.096%) was after maize.

Similar trend was noticed in the second season where the total phosphorus percentage was 0.118, 0.114, 0.108 and 0.098% for sorghum, cowpea, sunflower and maize, respectively.

In general, the total phosphorus content in the soil increased after harvesting the above summer preceding crops in the two seasons, in comparison with the check (after seeding summer crops). The increase in phosphorus content of the soil after sorghum is in harmony with the results obtained by Mohamed (1994) Maareg and Allam (1999).

1. 1. 4. Total potassium:

The effect of preceding crops on potassium percentage in the soil is shown in Table (3). Preceding crops did not affect potassium content of the soil in both seasons.

Potassium percentage in the soil after the studied preceding crops was nearly similar with very slight differences. It could be concluded that there was no pertinence between summer preceding crops and potassium content of the soil.

These results are in harmony with those obtained by EL-Debaby *et. al.,* (1984), Allam (1988), Meahasen (1990) and Mohamed (1994) who reported that potassium content in the soil was not affected by preceding crops.

1. 1. 5. Total organic matter:

The results in Table (3) indicated that the organic matter percentage in the soil was affected by preceding summer crops. In the first season, the highest value was recorded after sorghum (2.581%) followed by that after maize (2.483%), cowpea (2.309%) and sunflower gave the lowest value (2.286).

Similar trend was obtained in the second season, where the organic matter percentage was 2.528, 2.460, 2.294, 2.279% for sorghum, maize, cowpea and sunflower, respectively.

Similar results were obtained by Badr (1971) who found that presence of sorghum and maize in the rotation increased the soil organic matter content.

1. 1. 6. pH value :

Results shown in Table (3) revealed that the summer preceding crops did not affect pH value of the soil in both seasons . The pH value after the four summer preceding crops, sorghum, maize, cowpea and sunflower was nearly similar with slight differences.

It could be concluded that the there was no difference between preceding crops in pH value of the soil.

This result is in harmony with those obtained by Badr (1971), EL-Debaby (1971), Bashir (1980), Meahasen (1990), Mohamed (1994) and Maareg and Allam (1999).

1.2. Effect of preceding summer crops on biological properties of the soil:

Results shown in Table (4) indicated that the number of microflora in the soil was affected by preceding summer crops in the two seasons of 1997/98 and 1998/99. Maximum number of microflora was obtained after cowpea, whereas, the minimum one was after sunflower. This was true for the first and second seasons. Number of microflora in soil increased after harvesting than before seeding by 26.5, 11.8, 102.9 and 5.9% in the first season. Whereas, it increased by 27.0, 21.6, 137.8 and 5.4% in the second season, for sorghum, maize, cowpea and sunflower in both seasons, respectively. It could be concluded that number of microflora in soil after leguminous crops exceeded that after non-legumes. These results are in harmony with those obtained by Manzon (1936) who found that the highest bacterial numbers were recorded with legumes. Kadry *et. al.,*(1961) reported that the microbial densities of the rhizosphere of the leguminous plants were generally higher than non-leguminous plants. El-Debaby (1971) noticed that the number of bacteria in the soil was higher after legume crops as compared to non- legume ones. Bashir (1980), Meahasen (1990) and Maareg and Allam (1999) found that legume crops increased the total microflora in the soil as compared with cereal crops.

Table (4): Effect of preceding summer crops on soil microflora during 1997/98 and 1998/99 seasons.

Preceding **Crops**	***Number/gm dry weight X 10^6***			
	First season	increase %	Second season	Increase %
Cowpea	69	102.9	88	137.8
Maize	38	11.8	45	21.6
Sorghum	43	26.5	47	27.0
Sunflower	36	5.9	39	5.4
Before seeding summer crops	34	0.0	37	0.0

2. Growth parameters of sugar beet:

2.1. Effect of preceding summer crops on some growth parameters of sugar beet at different growth stages:-

Results in Tables from 5 to 10 show the effect of preceding summer crops on plant dry weight, leaf area per plant (LA), leaf area index (LAI), crop growth rate (CGR), net assimilation rate (NAR) and relative growth rate (RGR) of sugar beet plant.

2. 1. 1. Leaf area per plant (LA):

Concerning leaf area/plant (LA), the effect of preceding summer crops on this parameter is shown in Table (5). LA was significantly affected by preceding crops at all growth stages. At 100 days after sowing LA/plant was 1993.08, 1757287, 1313.56 and 1794.59 cm^2 whereas, it was 2802.96, 2404.45, 2090.80 and 2726.36 cm^2 at 121 days after sowing, respectively for cowpea, maize, sorghum and sunflower. At 142 days after sowing LA/plant was 3855.69, 3674.55, 2994.41 and 3766.45 cm^2 for the four mentioned crops. At 163 days after sowing cowpea (5697.01 cm^2) was superior to sunflower (5471.18 cm^2) which surpassed sorghum (4609.79 cm^2) as a preceding crop of sugar beet. Sugar beet preceded by maize crop gave the lowest LA/plant (4495.85 cm^2). In general, the highest value of LA/plant was produced from sugar beet plants grown after cowpea at all the different studied growth stages, whereas, the lowest one was produced from sugar beet preceded by sorghum at 100, 121 and 142 days after sowing and by maize at 163 days age.

Table (5): Leaf area per plant (cm^2) as affected by preceding summer crops at different growth stages as combined analysis of 1997/98 and 1998/99 seasons.

Preceding Crops	Days after planting			
	100	**121**	**142**	**163**
Cowpea	1993.08	2802.96	3855.60	5697.01
Maize	1757.87	2404.45	3674.55	4495.85
Sorghum	1313.56	2090.80	2994.41	4609.97
Sunflower	1794.59	2726.36	3766.45	5471.18
L.S.D. $_{0.05}$	190.20	308.60	675.8	850.40

Table (6): Leaf area index as affected by preceding summer crops at different growth stages as combined analysis of 1997/98 and 1998/99 seasons.

Preceding Crops	Days after planting			
	100	**121**	**142**	**163**
Cowpea	1.66	2.34	3.21	4.75
Maize	1.46	2.00	3.06	3.75
Sorghum	1.09	1.74	2.50	3.84
Sunflower	1.50	2.27	3.14	4.56
L.S.D. $_{0.05}$	0.14	0.25	0.54	0.70

2. 1. 2. Leaf area index (LAI):

Results of the effect of preceding crops on leaf area index (LAI) of sugar beet plant are shown in Table (6). The results indicated that the preceding crops showed significant effect on this character at all growth stages. LAI was 1.66, 1.46, 1.09 and 1.50, respectively, for cowpea, maize, sorghum, and sunflower at 100 days after sowing. These values became 2.34m 2.00m 1.71m and 2.27 at 121 days and 3.21, 3.06, 2.50 and 3.14 at 142 days for the four mentioned crops, respectively. At 163 days cowpea gave the highest leaf area index (4.75) followed by sunflower (4.56), then sorghum (3.84) whereas, maize gave the lowest LAI (3.75). The LAI of sugar beet plant could be arranged in a descending order according to the preceding crops at all growth stages as follows: cowpea, sunflower, maize and sorghum.

Growing sugar beet after cowpea produced higher LAI value at 163 days after sowing. On the other hand the lowest LAI value was produced by sugar beet plants following sorghum at 100 days of age. Similar results were obtained by Maareg and Allam (1999).

2. 1. 3. Total dry weight of plant:

The effect of preceding crops on total dry weight/plant at all growing stages is presented in Table (7). The data showed that the preceding crops had a significant effect on total dry weight/plant at all growing stages. At 100 days age the dry weight of sugar beet plant was 44.52, 36.86, 29.57 and 39.48 gm after cowpea, maize, sorghum and sunflower, respectively. These values were 64.77, 55.69, 46.41 and 61.93 gm at 121 days age and 104.96, 92.17,

Table (7): Total dry weight of plant (gm) as affected by preceding summer crops at different growth stages as combined analysis of 1997/98 and 1998/99 seasons.

Preceding Crops	Days after planting			
	100	121	142	163
Cowpea	44.52	64.77	104.96	179.12
Maize	36.86	55.69	92.85	156.14
Sorghum	29.57	46.41	86.17	144.92
Sunflower	39.48	61.93	98.65	161.79
L.S.D. $_{0.05}$	4.28	6.14	5.60	10.70

Table (8): Crop growth rate (gm/week) as affected by preceding summer crops at different growth stages as combined analysis of 1997/98 and 1998/99 seasons.

Preceding Crops	Growth periods		
	100-121	121-142	142-163
Cowpea	6.73	13.36	24.74
Maize	6.25	12.35	21.02
Sorghum	5.60	13.25	19.55
Sunflower	7.46	12.22	21.07
L.S.D. $_{0.05}$	0.60	0.80	3.51

86.17 and 98.65 gm at 142 days age, respectively for the mentioned preceding crops.

At 163 days age dry weight/plant after cowpea surpassed that after maize, sorghum and sunflower by 22.98, 34.20 and 17.33 gm, respectively. Cowpea as a preceding crop was better than sunflower and maize which surpassed sorghum in producing dry weight in sugar beet plant. The highest value of dry weight was obtained from sugar beet grown after cowpea at all growth stages. Whereas the lowest value was produced from plants grown after sorghum. These results are confirmed with those of Maareg and Allam (1999).

2. 1. 4. Crop growth rate (CGR):

The data in Table (8) indicated that preceding crops had a significant effect on crop growth rate (CGR) at all growth periods. Crop growth rate was 6.73, 6.25, 5.60 and 7.46 gm/week for cowpea, maize, sorghum and sunflower, respectively, throughout the period from 100- 121 days and 13.16, 12.35, 13.25 and 12.22 gm/week throughout the second period. CGR throughout the last period was the highest after cowpea. It surpassed maize, sorghum and sunflower by 3.72, 5.19 and 3.67 gm/week, respectively.

2. 1. 5. Net assimilation rate (NAR):

The results in Table (9) indicated that net assimilation rate (NAR) was significantly affected by preceding crops at all growth periods. The highest value of NAR was produced from sugar beet plants preceded by sorghum followed by that grown after maize then after cowpea and sunflower at the three growth periods. The

Table (9): Net assimilation rate ($mg/cm^2/week$) as affected by preceding summer crops at different growth stages as combined analysis of 1997/98 and 1998/99 seasons.

Preceding Crops	Growth periods		
	100-121	**121-142**	**142-163**
Cowpea	3.07	4.21	4.86
Maize	3.50	4.43	5.21
Sorghum	3.57	5.14	5.85
Sunflower	3.07	3.57	4.14
L.S.D. $_{0.05}$	0.45	0.61	0.62

Table (10): Relative growth rate as affected by preceding summer crops at different growth stages as combined analysis of 1997/98 and 1998/99 seasons.

Preceding Crops	Growth periods		
	100-121	**121-142**	**142-163**
Cowpea	33.72	26.15	22.51
Maize	29.14	24.96	22.44
Sorghum	31.27	28.29	23.33
Sunflower	29.00	24.68	22.50
L.S.D. $_{0.05}$	2.29	2.03	N.S

maximum value of NAR was obtained from growing sugar beet after sorghum (5.85 mg/cm^2/week) at the third growth period (142-163 days) and the lowest value was produced from sugar beet grown after cowpea and sunflower (3.07 mg/cm^2/week) at the first growth periods.

2. 1. 6. Relative growth Rate (RGR):

the data in Table (10) revealed that preceding crops significantly affected relative growth rate (RGR) at the first and second periods, i.e. 100-121 and 121-142 days after sowing, respectively. While, the results showed that preceding crops did not significantly affect RGR at 142-163 days growth period. RGR, in general, decreased with progress of plant age (Table 10).

The highest value of RGR was obtained from growing sugar beet after cowpea, followed by that grown after sorghum maize and sunflower without significant differences between these three crops in the first growth period (100-121 day after sowing) Whereas, in the second growth period (121-142 days after sowing), the RGR value after sorghum was higher than that after cowpea maize and sunflower without significant differences between them.

In the third period, (142-163 days after sowing) value of RGR could be arranged in a descending order according to preceding crops as follows: sorghum, cowpea, sunflower and maize without significant differences between them. Similar results were reported by Maareg and Allam (1999).

2. 2. Effect of nitrogen levels on some growth parameters of sugar beet at different growth stages:

2. 2. 1. Leaf area per plant (LA):

Nitrogen fertilization affected leaf area/plant at all growth stages as shown in Table (11). Leaf area increased to its maximum value by adding 90 Kg N/ fad at all growth stages. The differences between 90 Kg N/ fad were significant as compared with any of the nitrogen fertilizer level. The increase percentages at 90 Kg N/ fad were 70.25, 82.60, 53.27 and 41.78% as compared with zero level of nitrogen at 100, 121, 142 and 163 days after sowing, respectively. The highest value of leaf area/plant (6698.24 cm^2) was recorded with application of 90 Kg N/fad at growth stage of 163 days after sowing. This result reflects the important role of nitrogen in building up the photosynthetic area of plants.

These results confirmed those of Basha (1984) and Sahar Tawfik (1996) who reported that applying nitrogen up to 90 Kg/fad increased leaf area/plant of sugar beet.

2. 2. 2. Leaf area index (LAI):

The results in Table (12) revealed that LAI was significantly increased as nitrogen level increased up to 90 Kg N/fad. The increase percentages at 90 Kg nitrogen/ fad were 0.92, 1.68 1.52 and 1.63 as compared with zero level at 100, 121, 142 and 163 days after sowing, respectively. The highest values of LAI was recorded with application of 90 Kg N/fad at 163 days after sowing. These results are due to the positive effect of nitrogen on LA as mentioned before. Similar results were obtained by Kamel *et.*

Table (11): Leaf area per plant (cm^2) as affected by nitrogen levels at different growth stages as combined analysis of 1997/98 and 1998/99 seasons.

Nitrogen level	Days after planting			
	100	121	142	163
0	1571.002	2432.80	3502.17	4724.33
30	1818.25	2695.04	3896.71	5109.38
60	2416.69	3126.81	4870.81	6326.24
90	2674.64	4442.30	5367.64	6698.24
L.S.D. $_{0.05}$	255.95	291.48	390.53	367.91

Table (12): Leaf area index as affected by nitrogen levels at different growth stages as combined analysis of 1997/98 and 1998/99 seasons.

Nitrogen level	Days after planting			
	100	121	142	163
0	1.33	2.04	2.96	3.95
30	1.54	2.26	3.23	4.27
60	2.01	2.64	4.07	5.27
90	2.25	3.72	4.48	5.58
L.S.D. $_{0.05}$	0.23	0.24	0.39	0.30

al.,(1979), Hassanein (1979), Basha (1984), Obead (1988), Mahmoud *et. al.*, (1990) Sahar Tawfik (1996).

2. 2. 3. Total dry weight of plant:

The results in Table (13) indicated that nitrogen fertilization affected total dry weight at all growth stages. The differences in total dry weight were significant between 60 and 90 Kg N/ fad at all growth stages, whereas the differences in total dry weight between zero and 30 Kg N/fad were insignificant at 100 and 121 days after sowing respectively. The highest value of total dry weight (186.87 gm) was recorded by application of 90 Kg N/fad at growth stage of 163 days after sowing. The increase in total dry weight of sugar beet plant due to high nitrogen application is attributed to importance of nitrogen in activying metabolic process, which contributes to the accumulation of high amounts of metabolites in plant organs. These results confirmed those of Halvorson and Hartman (1975), Kamel *et. al.*,(1984) Zalat (1986), Obead (1988), Mahmoud *et. al.*,(1990), Assey *et. al.*,(1992), Sorour *et. al.*,(1992), Mirvat Gobarh (1993) and Sahar Tawfik (1996). On the other hand, Izsaki (1984) reported that dry weight of plant was not affected by nitrogen level.

2. 2. 4. Crop growth rate (CGR):

The results in Table (14) revealed that crop growth rate (CGR) was significantly affected by nitrogen fertilization at all growth periods. In general it could be concluded that CGR was significantly increased as nitrogen level increased up to 90 Kg N/ fad. The maximum value of CGR was recorded at 90 Kg N/ fad at the second and third growth periods. Such effect of nitrogen might

Table (13): Total dry weight of plant (gm) as affected by nitrogen levels at different growth stages as combined analysis of 1997/98 and 1998/99 seasons.

Nitrogen level	Days after planting			
	100	**121**	**142**	**163**
0	26.47	51.00	79.50	120.00
30	30.26	52.08	87.37	151.15
60	34.50	60.75	99.32	174.98
90	40.61	65.40	108.29	186.87
L.S.D. $_{0.05}$	4.19	4.61	7.84	11.8

Table (14): Crop growth rate (gm/week) as affected by nitrogen levels at different growth stages as combined analysis of 1997/98 and 1998/99 seasons.

Nitrogen level	Growth periods		
	100-121	**121-142**	**142-163**
0	8.19	9.50	13.52
30	7.28	11.76	21.27
60	8.75	12.86	25.20
90	8.24	14.32	26.19
L.S.D. $_{0.05}$	0.90	1.43	0.97

have been resulted from increasing photosynthetic area which consequently increased dry weight/plant as mentioned before. These results are in harmony with those found by Kamel *et. al.*,(1984) Obead (1988), Sayed *et. al.*,(1988), Sorour *et. al.*,(1992), Mirvat Gobarh (1993) and Sahar Tawfik (1996).

2. 2. 5. Net assimilation rate (NAR):

Table (15) revealed that net assimilation rate (NAR) was affected by nitrogen fertilization at all growth periods. NAR decreased significantly as N level increased up to 60 Kg N/ fad at the first and second growth periods. However the same trend was obtained at the third growth period (142-163 days). NAR decreased by increasing N level up to 90. Generally, NAR progressively increased as plant advanced towards maturity and reached its maximum value at the third growth period. The decrease in NAR due to increasing nitrogen level was reported by Mahmoud *et. al.*, (1990). On the other hand, Emara (1990), EL-Shafei (1991) and Mirvat Gobarh (1993) found that NAR was significantly increased by increasing nitrogen up to 120 Kg/ fad. While Ramadan (1986) reported that NAR was increased by increasing nitrogen level up to 60 Kg/fad but excess nitrogen over this level decreased it. In contrary, Sahar Tawfik (1996) found that NAR was significantly decreased with increasing nitrogen level up to 75 kg/ fad, but excess nitrogen over this level increased it.

2. 2. 6. Relative growth rate (RGR)

Relative growth rate (RGR) calculated at the first period (100-121 day after sowing) showed no significant differences due to nitrogen level (Table 16). There were significant differences in RGR

Table (15): Net assimilation rate ($gm/cm^2/week$) as affected by nitrogen levels at different growth stages as combined analysis of 1997/98 and 1998/99 seasons.

Nitrogen level	**Growth periods**		
	100-121	**121-142**	**142-163**
0	3.85	4.57	5.28
30	3.50	4.50	5.26
60	3.29	4.16	5.07
90	3.59	4.42	4.58
L.S.D. $_{0.05}$	0.21	0.24	0.18

Table (16): Relative growth rate as affected by nitrogen levels at different growth stages as combined analysis of 1997/98 and 1998/99 seasons.

Nitrogen level	**Growth periods**		
	100-121	**121-142**	**142-163**
0	19.78	24.92	18.45
30	21.32	25.86	24.06
60	25.32	27.47	24.34
90	25.65	28.85	22.74
L.S.D. $_{0.05}$	N.S.	1.36	1.30

between nitrogen levels at the second and third periods, i.e. 121-142 and 142-163 days after sowing, respectively. RGR in the third period was significantly increased by increasing nitrogen level up to 60 Kg N/fad but excess nitrogen over this level decreased it. Also, RGR increased till the second growth period, then decreased at the last one. It is worth mentioning that RGR progressively increased as plants advanced towards maturity and reached its maximum value at 121-142 days after sowing, then decreased at the third stage of growth, then it decreased due to senescence of older leaves. The increase in RGR due to increasing nitrogen level was reported by Ramadan (1986), Obead (1988), Emara (1990), El-Khatib (1991) and Sahar Tawfik (1996). While, Mahmoud *et. al.,*(1990) found that RGR decreased with increasing nitrogen levels. On the other hand, Sorour *et. al.,*(1992) reported that RGR was not significantly affected by nitrogen levels.

2.3. Effect of interaction between preceding summer crops and nitrogen level on growth parameters of sugar beet:

The effect of the interaction between preceding crops and nitrogen levels on. leaf area/plant, leaf area index, total dry weight/plant, crop growth rate, net assimilation rate and relative growth rate was not statistically significant in the two seasons.

3. Root characters of sugar beet :

3.1. Effect of preceding summer crops on root characters:

The effect of summer preceding crops on root characters, root length, root diameter and root weight of sugar beet plant is illustrated in Table (17).

3. 1. 1. Root length:

It is noticed that length of root was significantly affected by preceding crops in the first season only, (Table, 17).

The highest value of root length (40.43 and 39.80 cm) was obtained from growing sugar beet after cowpea in the first and second seasons respectively, followed by that grown after sunflower (39.50 and 39.25 cm), maize (38.00 and 38.25 cm) and sorghum (38.40 and 38.00 cm) without significant differences between these three crops in the first season.

In the second season, length of root could be arranged in a descending order according to preceding crops as follows: cowpea, sunflower, sorghum and maize without significant differences between them. It could be concluded that cowpea as a preceding crop favourably affected length of root in sugar beet.

The superiority of cowpea may be due to its deep roots which penetrates the soil for great depth, in addition to the highest porosity percentage of the soil recorded after cowpea as shown in Table (3).

Table (17) : Effect of preceding summer crops on root characters of sugar beet in 1997/98 and 1988/99 seasons.

Preceding Summer Crops	Root length (cm)		root diameter (cm)		Root weight (gm)	
	First season	*Second season*	*First season*	*Second season*	*First season*	*Second season*
Cowpea	40.43	39.80	10.00	11.25	720.42	750.42
Maize	38.00	38.00	8.90	10.50	686.67	650.24
Sorghum	38.40	38.25	8.7	10.25	580.42	545.12
Sunflower	39.50	39.25	9.00	11.25	693.34	680.19
L.S.D.$_{0.05}$	2.24	N.S	0.58	0.45	N.S	N.S

3. 1. 2. Root diameter:-

Results in Table (17) showed that the effect of preceding crop on root diameter of sugar beet was significant in both seasons.

In the first season, the maximum value of root diameter (10.00 cm) was found when growing sugar beet after cowpea. Whereas, no significant difference in root diameter was recorded when growing sugar beet after maize or sorghum or sunflower. Root diameter after these crops was 8.9, 8.7 and 9.0 cm, respectively.

In the second season, the highest value of root diameter was obtained from growing sugar beet after cowpea or sunflower (11.25 cm). Whereas the lowest root diameter (10.25 cm) was produced from growing sugar beet after sorghum. On the other hand there was no significant difference between maize and sorghum as preceding crops for sugar beet in root diameter.

It could be concluded that cowpea as a preceding crop was superior to maize and sorghum concerning root diameter in sugar beet.

3. 1. 3. Root weight:

The effect of preceding crops on the root weight is shown in Table (17). There were no significant differences in the weight of root due to growing sugar beet after the different crops in both seasons as presented in this Table.

The weight of root in sugar beet plant preceded by cowpea, maize and sunflower was higher than that grown after sorghum.

Generally, growing sugar beet after cowpea produced the highest values for root length, root diameter and root weight. These results agree with those reported by Maareg and Allam (1999) who found that sugar beet preceded by legumes gave the highest values for length, diameter and weight of root of sugar beet plant.

3.2. Effect of nitrogen level on root characters of sugar beet:-

The effect of nitrogen fertilizer levels on root length, root diameter and root weight is shown in Table (18).

3. 2. 1. Root length:-

Data showed that nitrogen fertilization significantly affected root length. This was true in the two seasons (Table, 18).

In the first season, root length was increased with increasing nitrogen level from zero up to 90 Kg N/fad without significant difference between 60 and 90 Kg N/fad levels. These increases were 4.2, 5.0 and 8.0 cm due to 30, 60 and 90 kg N/fad application, respectively compared with the unfertilized plants. The highest value of root length (43.00 cm) was obtained from applying 90 Kg N/fad, whereas the lowest value (35.00 cm) was obtained from the control treatment (zero N level).

In the second season, similar trend was recorded where the application of nitrogen at 30, 60 and 90 kg N/fad caused an increase of 4.9, 5.4 and 6.15 cm in root length, respectively over the control. The maximum value of root length (42.25 cm), was produced by applying 90 Kg N/fad . On the other hand, the minimum one (36.10 cm), was obtained from unfertilized sugar beet

Table (18) : Effect of nitrogen levels on root characters of sugar beet in 1997/98 and 1988/99 seasons.

Nitrogen Level	Root length (cm)		Root diameter (cm)		Root weight (gm)	
	First season	*Second season*	*First season*	*Second Season*	*First season*	*Second season*
0	35.00	36.10	8.80	9.00	580.17	600.52
30	39.20	41.00	9.00	10.00	720.34	840.13
60	40.00	41.50	10.00	11.25	800.44	960.12
90	43.00	42.25	10.50	11.50	1180.4	1210.05
$L.S.D._{0.05}$	3.58	2.22	0.80	1.24	179.10	126.05

plant. There were no significant differences between 30, 60 and 90 Kg N/fad on length of root. Such effect of nitrogen might be due to the increase in dry matter accumulated in the plants as a results of higher LAI and RGR accompanying its application. These results confirmed those obtained by Mahmoud (1979), Hanna *et. al.,* (1988), Sayed *et. al.,* (1988) Emara (1990), Mirvat Gobarh 1993), Sahar Tawfik (1996) and Ibrahim (1998)

3. 2. 2. Root diameter:-

The results in Table (18) revealed that nitrogen levels exhibited significant effects on root diameter in both seasons.

The results in the two seasons, showed that increasing nitrogen levels up to 90 Kg N/fad increased root diameter, with no significant differences between adding 30 Kg N/fad and the control (zero level) and between 60 and 90 Kg N/fad. The root diameter of sugar beet plant significantly increased by 0.2, 1.2 and 1.7 cm as a result of increasing nitrogen level from 0 to 30, 60 and 90 kg N/fad, respectively (Table, 18) in the first season. These increases were 1.0, 2.25 and 2.5 cm in the second season. Such effect of nitrogen may be due to the increase in dry matter accumulated in the root as a result of higher LAI, and RGR accompanying its application.

These findings are in agreement with those of Kamel *et. al.,* (1984), Taha (1985), EL-Shafei (1991), Mirvat Gobarh (1993), Sahar Tawfik (1996) and Ibrahim (1998).

3. 2. 3. Root weight:-

Data presented in Table (18) indicated that nitrogen levels had a significant effect on root weight in both seasons. Each nitrogen increment was associated with a gradual increase in root weight.

In the first season, the data showed that adding 30, 60 and 90 Kg N/fad increased the root weight with about 24.16, 37.97 and 103.46%, respectively as compared with zero level, with no significant difference between 30 and 60 Kg N/fad.

Also, in the second season the increase in nitrogen level from 0 to, 30, 60 and 90Kg /fad caused a remarkable increase in weight of root . These increases were 239.61,359.60,and 609.53 gm for the three mentioned levels, respectively compared with the zero level without significant differences between zero and 30 levels. Such effect of nitrogen is due to its role in improving sugar beet growth in terms of LAI, RGR and root dimensions (root length and root diameter) as discussed before.

Similar results were reported by Mahmoud (1979), Obead (1988), Kamel *et. al.*,(1989) Emara (1990) EL-Khatib (1991), Mirvat Gobarh (1993), Saher Tawfik (1996) and Ibrahim (1998).

3.3. Effect of the interaction between summer preceding crops and nitrogen levels on root characters:-

The effect of the interaction between preceding crops and nitrogen levels on root characters (root length, root diameter and root weight) was not significant in both seasons, consequently the data were excluded.

4. Yield:

4.1. Effect of preceding summer crops on yields of sugar beet :-

The data in Table (19) show the effect of preceding crops on top, root biological and sugar yields of sugar beet during 1997/98 and 1998/99 seasons.

4. 1. 1. Top yield (tons/fad):

Top yield of sugar beet was not significantly affected by preceding crops (Table, 19). This was clearly shown in the first and second seasons.

In the first season, growing sugar beet after cowpea, maize and sunflower increases the top yield of sugar beet by 1.22, 0.13 and 0.47 tons/fad, respectively as compared with the yield after sorghum.

These increases were 1.44, 0.94 and 0.94 tons/fad in comparison with the top yield after sorghum in the second season.

It could be concluded that cowpea was superior to maize and sunflower as preceding crop for sugar beet, and that maize and sunflower were better than sorghum which was the worst preceding crop for sugar beet.

Sorghum is considered the poorest preceding crop because of the wide C/N ratio of its residues. The decomposition of such residues requires high amounts of nitrogen extracted from the soil by soil microorganisms.

Table (19) : Effect of preceding summer crops on yield components of sugar beet in 1997/98 and 1988/99 seasons.

Preceding summar crops	Top yield		Root yield		Biological yield		Sugar yield	
	First season	Second season	First season	Second season	First season	Second season	First season	Second season
Cowpea	6.57	5.19	23.00	24.50	29.57	29.69	3.96	4.28
Maize	5.48	4.69	15.10	17.69	20.58	22.38	2.51	2.96
Sorghum	5.35	3.75	14.03	16.56	19.38	20.31	2.21	2.64
Sunflower	5.82	4.69	19.84	21.06	25.66	25.75	3.24	3.46
L.S.D.$_{0.05}$	N.S	N.S	3.86	4.26	5.48	4.31	0.60	1.37

The previous results were in agreement with those obtained by Cootta and Donattell (1990) and Maareg and Allam (1999) who indicated that sugar beet grown after legumes gave the highest top yield compared with the yield after maize or sorghum.

4. 1. 2. Root yield (Tons/fad):

Root yield of sugar beet as affected by preceding crops is illustrated in Table(19). Results revealed that preceding crops significantly affected the root yield of sugar beet in both seasons.

In the first season, the root yield/fad was 23.00, 15.10, 14.03 and 19.84 tons for sugar beet preceded by cowpea, maize, sorghum and sunflower, respectively. Sugar beet preceded by cowpea gave the heaviest root yield (23.00 tons/fad) followed by that preceded by sunflower (19.84 tons/fad), then maize (15.10 tons/fad). Sorghum was the worst preceding crops for sugar beet in root yield/fad, (14.03 ton/fad).

In the second season, the root yield (tons/fad) was 24.50, 17.69, 16.56 and 21.06 when growing sugar beet after cowpea, maize, sorghum and sunflower, respectively. Root yield of sugar beet /fad could be arranged in a descending order according to the preceding crops as follows: cowpea (24.50)> sunflower (21.06)> maize (17.69)> sorghum (16.56).

Results indicated that cowpea as a preceding crop was superior to maize, and sunflower in root yield production in sugar beet. On the other hand, sorghum was inferior in this respect.

The superiority of cowpea as a preceding crop for sugar beet may be due to its deep roots which penetrate the soil for great depth. In addition, the presence of cowpea in the rotation increased the organic matter content of the soil as reported by Meahasen (1990) and Maareg and Allam (1999).

These results confirmed those obtained by Cootta and Donattell (1990) who indicated that sugar beet root yield after legumes was higher than that after maize. On the other had, Maareg and Allam (1999) found that root yield of sugar beet grown after legumes surpassed that grown after maize or sorghum.

4. 1. 3. Biological yield (Tons/fad):

Results in Table (19) showed that biological yield of sugar beet was significantly affected by the preceding crops in both seasons.

In the first season, the highest biological yield/fad was produced from growing sugar beet after cowpea (29.57 tons/fad) followed by that after sunflower (25.66 tons/fad) then after maize (20.58 tons/fad). On the other hand, sugar beet biological yield preceded by sorghum was the lowest one, (19.38 tons/fad).

Similar trend was recorded in the second season, where the biological yield of sugar beet grown after cowpea, sunflower, maize, and sorghum was 29.69, 25.75, 22.38 and 20.31 tons/ fad, respectively.

It could be concluded that cowpea is the best preceding crop for sugar beet for producing the highest biological yield and that sunflower and maize were better than sorghum in this respect.

The superiority of cowpea as a preceding crop for sugar beet may be due to the increase in top yield, and root yield. This increase may be due to the presence of cowpea in the rotation, which increased the soil organic matter. NPK content of the soil in addition to the high number of micro-organisms which contribute to quick decomposition of the organic matter in the soil, (Maareg and Allam, 1999). The inferiority of sorghum as a preceding crop for sugar beet may be due to the wide C/N ratio of its roots. The decomposition of such residues by micro-organism requires longtime and high amount of nitrogen taken from the soil.

Maareg and Allam (1999) showed that sugar beet biological yields were 32.17 and 29.83 tons/fad after cowpea and peanut, respectively compared with 23.87 and 19.06 tons after maize and sorghum, respectively.

4. 1. 4. Sugar yield (Tons/fad):-

Sugar yield/fad was significantly affected by preceding crops in 1997/98 and 1998/99 seasons as shown in Table (19).

The results indicated that cowpea as a preceding crop for sugar beet gave the maximum sugar yield/fad (3.96 and 4.28 ton/fad) in the first and second seasons respectively. While, sorghum was the worst preceding crop for sugar beet in sugar yield (2.21 and 2.64 tons/fad) in 1997/98 and 1998/99 seasons, respectively.

On the other hand, there were insignificant differences between maize and sorghum as preceding crops for sugar beet in the first season, and between maize, sorghum and sunflower in the second season, Sugar beet yield after cowpea surpassed that after sunflower, maize and sorghum by 0.71, 1.45 and 1.75 in the first season, respectively. This superiority was 0.82, 1.32 and 1.64 compared with sunflower, maize and sorghum in the second season. Similar results were also, reported by Cootta and Donattell (1990), and Maareg and Allam (1999).

4.2. Effect of nitrogen levels on yields of sugar beet :-

Yields of sugar beet, namely; tops, roots biological and sugar as affected by nitrogen fertilization during 1997/98 and 1998/99 seasons is presented in Table (20).

4. 2. 1. Top yield (Tons/fad):

Data in Table (20) revealed that top yield/fad was significantly affected by nitrogen level in the first and second seasons. Increasing nitrogen application from 0 to 30, 60 and 90 kg/fad, increased top yield by 1.25, 1.93 and 3.56 tons/fad, respectively, over the control in the first season. In the second season, top yield increased by 1.81, 1.87 and 3.18 due to increasing nitrogen level from zero up to 30, 60 and 90 kg/fad, respectively. In general, the results of both seasons showed no significant differences between plants received 30 and 60 Kg N/fad levels. The maximum top yields/fad were 7.63 and 6.06 tons obtained by applying 90Kg N/fad in the first and second seasons, respectively. Whereas, the minimum yields (4.07 and 2.88 tons/fad) were produced without nitrogen fertilizer in 1997/98 And 1998/99 seasons, respectively. It

Table (20) : Effect of Nitrogen levels on yields of sugar beet (tons/fad) in 1997/98 and 1988/99 seasons.

Characters	Top yield		Root yield		Biological yield		Sugar yield	
Nitrogen	First season	Second season	First season	Second season	First season	Second season	First season	Second season
0	4.07	2.88	11.19	11.81	15.25	14.69	1.61	1.69
30	5.32	4.69	14.07	17.50	19.38	22.19	2.15	2.68
60	6.00	4.75	18.72	20.00	24.72	24.75	3.13	3.47
90	7.63	6.06	21.00	23.50	28.63	29.31	3.93	4.38
L.S.D. 0.05	0.99	0.68	1.83	2.48	1.46	2.55	0.52	0.81

could be concluded that increasing nitrogen application to sugar beet plants up to 90 Kg N/fad consistently increased top yield/fad. The increase in nitrogen application increases the amount of metabolites, which are utilized in building new organs in plant such as leaves. Similar results were reported by Taha (1985), Obead (1988), Mahmoud *et. al.,* (1990), Mirvat Gobarh (1993), Sahar Tawfik (1996) and Ibrahim (1998). On the other hand, Anderson and Peterson (1988) reported that increasing nitrogen level up to 275 Kg/ha had no effect on top yield.

4. 2. 2. Root yield (tons/fad):-

Root yield/fad was significantly increased by increasing nitrogen level up to 90 Kg N/fad in both seasons (Table, 20). These increases were 2.88, 7.53 and 9.81 tons/fad for the three mentioned N levels (30.60 and 90 Kg N/fad), respectively as compared with the control treatment (zero level) in the first season.

Similar trend was obtained in the second season. The root yield was 11.81, 17.50, 20.00 and 23.50 tons for the four studied nitrogen levels (0, 30, 60, and 90 Kg N/fad), respectively as shown in Table (20).

The increase in root yield due to the increase in nitrogen level clearly indicated the prominent role of nitrogen on vegetative growth. Nitrogen increases the metabolic activity in plants which contributes to the increase in the accumulation of metabolites in root tissues and this in turn increases the weight of root. Similar conclusion was reported by Prasad and Singh (1983), Taha (1985), Obead (1988), Emara (1990), Mahmoud *et. al.,* (1990), Assey *et.*

al., (1992), Mirvat Gobarh (1993), Sahar Tawfik (1996) and Ibrahim (1998).

4. 2. 3. Biological yield (Tons/fad):-

Data in Table (20) indicated that increasing nitrogen level increased significantly the biological yield of sugar beet /fad in both seasons. Biological yield increased by 4.13, 9.47 and 13.38 tons as a result of increasing nitrogen level from 0 to 30, 60 and 90 kg N/fad, respectively in the first season, the increase in biological yield was 7.50, 10.06 and 14.62 tons/fad due to increasing nitrogen application from 0 to 30, 60 and 90 kg /fad, respectively, in the second season. The highest level of nitrogen (90 Kg/fad) produced the highest biological yields (28.63 and 29.31 tons/fad) in the first and second seasons, respectively. On the other hand, the lowest yields were 15.25 and 14.69 tons/fad in the first and second season, respectively. The increase in biological yield of sugar beet due to the increase in nitrogen level is a result of the effect of nitrogen in increasing the top and root yields. Nitrogen increases the metabolic activity in plants, which contributes to the increase in the accumulation of metabolites in plant tissues and this in turn increases the weight of plant. Similar result was reported by Ibrahim (1998).

4. 2. 4.Sugar yield (Tons /fad):-

The results in Table (20) revealed that, sugar yield/fad was significantly affected by nitrogen level in the first and second seasons.

In the first season, nitrogen fertilization significantly increased the sugar yield /fad, these increases were 0.54, 1.52 and 2.32 tons due to the application of 30, 60 and 90 kg/fad, respectively over the unfertilized plants, and any increase in nitrogen applied was followed by a respective increment in sugar yield (tons/fad). While, in the second season there was no significant difference between plant received 30 and 60 Kg N/fad. Raising nitrogen levels from o up to 30, 60 and 90 kg/fad caused the increases of 0.99, 1.78 and 2.69 tons of sugar as compared with the control treatment. Such effect may be due to improved sugar beet growth in terms of more dry matter accumulation, higher LAI, CGR which contributed to high root yield as well as increased root size and weight accompanying higher nitrogen level. These results are in agreement with those reported by Carter and Traveller (1981), Taha (1985), Obead (1988), Kamel *et. al.,* (1989), Mahmoud *et. al.,*(1990), Mirvat Gobarh (1993), Sahar Tawfik (1996) and Ibrahim (1998)

4.3. Effect of the interaction between preceding summer crops and nitrogen levels on sugar beet yields:-

The effect of the interaction between preceding summer crops and nitrogen levels on top yield in both seasons and sugar yield in the second season was not significant, consequently the data were excluded. However, root yield, biological yield in the two seasons and sugar yield in the first season were affected significantly by the interaction between preceding summer crops and nitrogen levels (Tables 21, 22 and 23).

4. 3. 1. Root yield (tons/fad):-

The results of root yield as affected by the interaction of preceding summer crops with nitrogen fertilization are shown in Table (21).

In general in both seasons it can be concluded that root yield of sugar beet grown after the different preceding crops under study responded to nitrogen application up to 90 Kg/fad. It reached its maximum yield at 90Kg N/fad. On the other hand, its minimum value was obtained with zero level of nitrogen. This was true after all preceding crops.

With regard to the effect of preceding crops under nitrogen levels in the first and second seasons it could be shown from Table (21) that cowpea as a preceding crop for sugar beet gave the highest root yield/fad under all nitrogen levels. Whereas, the lowest root yield was produced from sugar beet preceded by sorghum under the different nitrogen levels used.

However, the maximum root yields/fad in the first and second seasons (26.50 and 28.50 tons), were respectively obtained from growing sugar beet after cowpea with the application of 90 Kg N/fad. Whereas, the minimum values (10.13 and 9.75 tons/fad), were respectively produced from growing sugar beet after sorghum without nitrogen application.

Table (21): Effect of the interaction between summer preceding crops and nitrogen levels on root yield (tons/fad)in 1997/98 and 1988/99 seasons.

Preceding Crops	*Nitrogen levels*							
	First season				**Second season**			
	Zero	*30 Kg/fad*	*60 Kg/fad*	*90 Kg/fad*	*Zero*	*30 Kg/fad*	*60 Kg/fad*	*90 Kg/fad*
Cowpea	12.00	15.75	20.75	26.50	17.25	19.75	23.50	28.50
Maize	11.00	13.33	15.25	19.25	10.50	16.75	19.00	21.25
Sorghum	10.13	13.00	15.25	17.75	9.75	13.50	17.50	19.25
Sunflower	11.63	13.88	18.63	22.50	12.75	15.50	20.00	24.50
L.S.D. $_{0.05}$	3.16				3.82			

4. 3. 2. Biological yield (tons/fad):-

The effect of interaction between preceding summer crops and nitrogen levels on biological yield/fad in the both seasons in presented in Table (22).

Regarding nitrogen levels it is clear from Table (22) that the maximum biological yield /fad was recorded at 90 Kg N/fad when sugar beet was grown after all preceding crops, (Cowpea, Maize, Sorghum and sunflower) with no significant difference between maize and sorghum, and between maize and sunflower. These results are true in both seasons.

The highest biological yields/.fad (33.75 and 36.75 tons) in the first and second seasons, respectively were obtained when sugar beet was grown after cowpea which received 90 Kg N/fad. On the other hand, the lowest ones (13.88 and 12.25 tons/ fad) were produced after sorghum as a preceding crop for sugar beet without nitrogen fertilizer.

4. 3. 3. Sugar yield (tons/fad):-

Table (23) shows a significant interaction effect on sugar yield only in the first season.

Sugar beet grown after cowpea gave higher sugar yield under different nitrogen levels than that preceded by maize, sorghum or sunflower. The highest sugar yield (4.35 tons/fad) was given from plants grown after cowpea and fertilized with 90 kg N/fad, whereas, the lowest sugar yield (1.21 tons/fad) was obtained from plants grown after maize without nitrogen fertilizer application.

Table (22) : Effect of the interaction between summer preceding crops and nitrogen levels on Biological yield (tons/fad)in 1997/98 and 1988/99 seasons.

Preceding Crops	*Nitrogen level*							
	first season				Second season			
	Zero	*30 Kg/fad*	*60 Kg/fad*	*90 Kg/fad*	*Zero*	*30 Kg/fad*	*60 Kg/fad*	*90 Kg/fad*
Cowpea	16.38	22.38	27.75	33.75	20.50	25.25	28.25	36.75
Maize	14.75	18.58	20.13	26.63	13.25	21.25	24.25	27.00
Sorghum	13.88	17.88	20.75	24.25	12.25	18.00	22.25	25.50
Sunflower	16.00	19.13	22.50	28.01	14.75	19.50	24.00	29.50
L.S.D. $_{0.05}$	3.22				5.85			

Table (23) : Effect of the interaction between summer preceding crops and nitrogen levels on sugar yield (tons/fad)in 1997/98 and 1988/99 seasons.

	Nitrogen level							
Preceding Crops	**first season**				**Second season**			
	Zero	*30 Kg/fad*	*60 Kg/fad*	*90 Kg/fad*	*Zero*	*30 Kg/fad*	*60 Kg/fad*	*90 Kg/fad*
Cowpea	1.70	2.55	3.26	4.35	2.37	3.10	4.41	4.50
Maize	1.21	2.18	2.77	4.16	1.37	3.11	4.03	5.41
Sorghum	1.42	2.11	2.53	3.06	1.16	2.19	3.49	4.41
Sunflower	1.62	2.11	2.53	3.48	1.95	2.34	3.32	4.14
L.S.D. $_{0.05}$	0.53				N.S.			

Finally, from the data in Tables (21, 22 and 23). It could be concluded that cowpea is the best preceding crop for sugar beet given high amounts of nitrogen for producing the maximum root sugar and biological yields/fad and that maize, and sunflower are better than sorghum when sugar beet is fertilized with 90 Kg N/fad.

These results are in harmony with those obtained by Kapur and Kanwar (1989) who found that the optimum yield of root and sugar yields of sugar beet were obtained with increasing N-level after pigeanpea. Cootta and Donattell (1990) indicated that sugar beet yield with fertilizer was highest when it was grown after legumes.

Also, Maareg and Allam (1999) reported that the highest yields of sugar beet were obtained from growing sugar beet after legumes with 90 Kg N + 30 tons FYM/fad.

5- Technological characters:-

5.1. Effect of preceding summer crops on some technological characters:

The results in Table (24) show the effect of preceding summer crops on percentages of total soluble solids (T.S.S) and sucrose in sugar beet roots and juice purity during 1997/98 and 1998/99 seasons.

5.1.1. Total soluble solids percentage (T.S.S%):-

Results in Table (24) showed that, the effect of preceding crops on T.S.S% in sugar beet juice was significant in both seasons.

Table (24) : Effect of preceding summer crops on some technological characters of sugar beet in 1997/98 and 1988/99 seasons.

Preceding Crops	Total soluble solids %		Sucrose %		Juice purity %	
	First season	*Second season*	*First season*	*Second season*	*First season*	*Second season*
Cowpea	19.69	21.13	17.29	17.64	87.81	83.48
Maize	19.56	19.75	16.31	16.00	83.38	81.01
Sorghum	18.94	19.50	15.75	15.68	83.16	80.41
Sunflower	20.38	20.00	16.42	16.51	80.57	82.55
$L.S.D._{0.05}$	0.71	1.10	0.86	1.13	2.00	1.07

In the first season, the highest T.S.S% (20.38%) was obtained from growing sugar beet after sunflower followed by that grown after cowpea (19.69%%) and maize (19.56%). Whereas, the lowest T.S.S% (18.94%) was produced from growing sugar beet after sorghum.

In the second season, the maximum T.S.S.%. (21.13%) was found when growing sugar beet after cowpea followed by that after sunflower (20.00%). Whereas, no significant difference in T.S.S.% was recorded when growing sugar beet after maize or sorghum or sunflower. On the other hand, the minimum T.S.S.% (19.50%) was obtained from sorghum as a preceding crop for sugar beet.

These results are in agreement with those obtained by Maareg and Allam (1999) who found that the highest value of T.S.S.% was obtained from sugar beet grown after cowpea and the lowest value produced from plants grown after sorghum in sandy soils at Bostan region.

5. 1 .2. Sucrose percentage:-

Sucrose percentage was significantly affected by preceding crops in both seasons as shown in Table (24).

In the first season, the highest value of sucrose % was obtained from sugar beet plants preceded by cowpea (17.29%) followed by that grown after sunflower (16.42%) then after maize (16.31%). Sorghum was the worst preceding crops for sugar beet regarding sucrose percentage in roots (15.75%).

Similar trend was obtained in the second season where the sucrose percentages in roots of sugar beet grown after cowpea surpassed that grown after the three studied preceding crops. These percentage were 17.64, 16.51, 16.00 and 15.68, respectively for cowpea, sunflower, maize and sorghum as preceding crops for sugar beet.

It could be concluded that cowpea is the best preceding crop for sugar beet for obtaining the highest value of sucrose percentage. Similar results were obtained by Maareg and Allam (1999) who found that sugar beet grown after cowpea gave the highest sucrose percentage than after maize or sorghum.

5. 1. 3. Purity percentage:-

Purity percentage was significantly affected by preceding crops in 1997/98 and 1998/99 seasons as presented in Table (24).

It is clear that cowpea as a preceding crop for sugar beet gave the highest purity percentage (87.81 and 83.48%) in roots juice in the first and second seasons, respectively, followed by maize (83.38 and 81.01%) and sorghum (83.16 and 80.41%). While, sunflower and sorghum were the worst preceding crops for sugar beet in purity percentage (80.57 and 80.41%) in the first and second seasons, respectively). On the other hand, there were no significant differences between maize and sorghum as preceding crops for sugar beet in juice purity percentage in both seasons.

This emphasyed with those obtained by Maareg and Allam (1999) who reported that sugar beet grown after cowpea gave highest purity percentage than after sorghum or maize.

5.2. Effect of nitrogen levels on some technological characters:

The results in Table (25) show the effect of nitrogen fertilization on percentage of total soluble solids (T.S.S) and sucrose in sugar beet roots and juice purity of roots in 1997/98 and 1998/99 seasons.

5.2.1.Total soluble solids percentage (T.S.S. %):-

Data in Table (25) showed that, percentage of T.S.S. was significantly affected by nitrogen treatments, and this was true in both seasons.

In the first season, the results revealed that T.S.S % was significantly increased with increasing nitrogen levels from zero to 90 Kg N/fad. But there was no significant difference between 30 and 60 Kg N/fad levels. Application of 30, 60 and 90 kg N/fad increased T.S.S.% from 16.84 at control to 18.25, 19.64 and 22.44%, respectively (Table, 25).

In the second season, it could by concluded that adding 30 Kg N/fad did not affect T.S.S. % when compared with the unfertilized treatment (0 Kg N/fad). But adding 60 or 90 Kg N/fad significantly increased T.S.S. % as compared with the unfertilized or 30 Kg N/fad treatments.

The greatest T.S.S% (22.44 and 23.28%) were obtained from sugar beet plants received 90 Kg N/fad. in the first and second seasons, respectively. On the other hand, the lowest ones (16.84

Table (25) : Effect of nitrogen levels on some technological characters of sugar beet in 1997/98 and 1988/99 seasons.

Nitrogen level (Kg/fad)	Total soluble solids %		Sucrose %		Juice purity %	
	First season	*Second season*	*First Season*	*Second season*	*First season*	*Second season*
0	16.84	17.38	14.42	14.42	85.63	82.99
30	18.25	18.63	15.28	15.28	83.73	82.02
60	19.64	21.44	16.43	17.37	83.66	81.02
90	22.44	23.28	18.63	18.63	83.02	80.03
L.S.D.$_{0.05}$	1.41	1.60	1.15	1.38	N.S	N.S

and 17.38%) were recorded at non-fertilized plants in both seasons, respectively.

In this respect, Sahar Tawfik (1996) found that T.S.S.% in beet root was significantly increased from 16.05 to 18.42% due to increasing nitrogen fertilization from 0 to 60 Kg N/fad. On the other hand, Parashar *et al.,* (1976) reported that T.S.S% in juice content of beet root was significantly reduced from 19.99 to 17.99% due to increasing nitrogen levels from 50 to 200 kg/ha. Ibrahim (1998) recorded that T.S.S.% increased with the increase in nitrogen application up to 50 kg/fad but further increase in nitrogen application up to 100 kg/fad decreased T.S.S%.

5.2.2. Sucrose percentage:-

Nitrogen levels exhibited a significant effect on sucrose percentage in both seasons (Table 25). Increasing nitrogen level up to 90 Kg N/fad significantly increased the sucrose percentage in the root. The results of the first season indicated no significant difference between zero and 30 Kg N/ fad. levels. Also there was no significant difference between zero and 30 Kg N/fad as well as between 60 and 90 Kg N/fad levels in the second season.

Generally, sucrose percentage increased from 14.42 at control to 15.28, 16.43 and 18.63% by increasing nitrogen level up to 30, 60 and 90 kg/fad in the first season. In the second season, raising nitrogen levels from 0 to 30, 60 and 90 kg/fad increased sucrose percentage from 14.42 to 15.28, 17.37 and 18.63%, respectively.

These results are generally in the same line with those obtained by Ryabchuk and Lyashinskii (1972) who found that the increase on nitrogen level up to 120 Kg/ha was accompanied with a increase in sucrose percentage. Sahar Tawfik (1996) reported that increasing nitrogen fertilization from zero to 60 Kg/fad increased root sugar percent from 13.35 to 15.73%. On the other hand, several investigators have reported that excessive nitrogen decreased sucrose percentage of beets. Among them are Kamel *et al.,* (1984) Assey *et. al.,* (1985) Emara (1990), EL-Khatib (1991), Mirvat Gobarh (1993) and Ibrahim (1998). While, application of nitrogen levels up to 80 Kg/fad, (Draycott and Russell, 1974) and 60 Kg/fad (Mahmoud *et. al.,* 1990) had no significant effect on sucrose percentage in the beet roots.

5.2.3. Purity percentage :-

The effect of nitrogen levels on percentage of purity is shown in Table (25). The results clearly showed that purity percentage in root juice was not significantly affected due to adding nitrogen fertilizer up to 90 Kg/fad. This was clearly shown in the first and second seasons.

Similar findings were reported by Basha (1984), Assey *et. al.,* (1985) who found that purity percentage was not significantly affected by nitrogen levels. On the other hand, EL-Shafei (1991) and El-Geddawy *et. al.,* (1992) found that purity percentage significantly increased with increasing the level of nitrogen from 40 to 75 Kg/fad.

5.3. Effect of the interaction between summer percentage crops and nitrogen levees:

The effect of the interaction between preceding crops and nitrogen levels on total soluble solids, sucrose and purity percentage was not statistically significant in both the two seasons, consequently, the data were excluded.