RESULTS AND DISCUSSION

Part one : Effect of mineral N fertilizer and Biogas sludge on grain yield and quality of maize .

The present study aimed to investigate the effect of N fertilizer levels (0 , 50 , 100 and 150 Kg N/fed.)and two levels of Biogas sludge(zero and 5m^3/fed.) on maize . The interaction effects of the two experimental factors on the studied traits were considered .

The results included flowering date, some growth characters, yield components, grain, straw and biological yields, NPK and total carbohydrate contents in grain, N use efficiency and apparent N recovery . Also, mineral and chemical contents in soil at harvest in 1996 and 1997 seasons as affected by N and Biogas sludge fertilizers were studied .

A-Effect of soil application of N on maize :

Results for the effect of nitrogen fertilizer levels on tasseling and silking dates , growth characters at 80 days from planting , grain yield, its components, NPK and total carbohydrates contents in grain and their yields ,N use efficiency and apparent N recovery in grain in both seasons, are shown in Tables (6,7,8,9,10,11 and 12) .

1- Days to tasseling and silking :

Nitrogen fertilizer caused a significant decrease in number of days to 50% tasseling and silking. Adding 150 Kg N /fed. significantly decreased tasseling and silking dates compared with the control treatment in both seasons (Table 6). However, the difference

between 100, 150 Kg N/fed as well as between zero and 50 kg N/fed levels in both seasons were insignificant . Application of nitrogen levels (50 ,100, 150 Kg N/fed) significantly decreased tasseling date over the check treatment by 3.0, 6.2 and 7.0 days in the 1st season and by 1.5 , 2.9 and 3.4 days in the 2nd season , respectively . On the other side, the same respective N levels significantly decreased

Table (6) : Effect of nitrogen fertilizer levels on tasseling and silking dates of maize plant in 1996 and 1997 seasons .

Characters / N-levels (Kg/fed)	Days from plating to	
	50 % tasseling	50 % silking
1996 season		
0	63.7 b	69.1 c
50	60.7 b	67.6 c
100	57.5 a	65.1 ab
150	56.7 a	63.1 a
1997 season		
0	61.8 c	63.6 b
50	60.3 b	63.0 b
100	58.9 a	61.9 ab
150	58.4 a	61.5 a

silking date over the control treatment by 1.5 , 4.0 and 6.0 days in the 1st season and by 0.6 , 1.7 and 2.1 days in the 2nd season, respectively . These results may be due to the positive effect of N on tasseling and silking dates due to its role on C/N ratio in maize plants . It is clear that N application indicated the role of N in the formation of sexual organs and encouraged the meristematic activity

Table (7): Effect of N fertilizer levels on growth characters of maize at 80 days from planting in 1996 and 1997 seasons .

Characters N-levels (Kg/fed)	Plant height (cm)	Ear height (cm)	Stem diameter (cm)	No.of green leaves/plant	No. of dry leaves/plant	Ear leaf area (cm^2)	L. A. I.	Fresh weight (g)			Total fresh weight / plant (g)	Dry weight (g)			Total dry weight / plant
								Leaves / plant	Stem */ plant	Ear / plant		Leaves/ plant	Stem* / plant	Ear/ plant	
1996 season															
0	223.8 a	123.5 a	2.20 a	11.44 a	3.39 b	503.3 a	3.8 a	72.9 a	159.2 a	125.6 a	357.7 a	25.1 a	50.8 a	41.9 a	117.8 a
50	252.4 b	131.9 b	2.51 b	11.48 a	3.10 b	611.9 b	4.4 b	118.2 b	220.2 b	162.7 b	501.1 b	39.4 b	73.6 b	54.0 b	167.0 b
100	264.9 c	139.8 c	3.25 c	11.58 a	2.64 a	712.0 c	5.1 c	141.3 c	252.4 c	203.9 c	597.6 c	47.6 c	88.3 c	68.1 c	204.0 c
150	272.4 d	143.6 d	3.44 c	11.59 a	2.54 a	742.4 c	5.2 c	147.7 d	267.5 d	214.3 d	629.5 d	50.2 c	89.4 c	71.6 c	211.2 c
1997 season															
0	217.3 a	138.9 a	2.15 a	12.15 a	3.35 b	523.2 a	3.5 a	78.8 a	155.4 a	123.7 a	357.9 a	28.0 a	52.9 a	43.9 a	124.8 a
50	230.6 b	142.5 b	2.63 b	12.16 a	3.00 b	591.9 b	4.0 b	122.8 b	196.8 b	170.4 b	490.0 b	44.4 b	75.6 b	56.0 b	176.0 b
100	247.6 c	147.0 c	3.04 c	12.24 a	2.59 a	739.2 c	5.0 c	151.1 c	253.7 c	207.7 c	612.5 c	53.7 c	90.3 c	75.2 c	219.0 c
150	248.6 c	147.1 c	3.11 c	12.25 a	2.51 a	744.7 c	5.1 c	153.2 c	257.4 c	215.4 c	628.0 c	54.3 c	91.6 c	75.9 c	228.0 c

* Stem/plant = stem, sheaths and tassel .

Such increases over the control treatment in 1997 season were 6.1 , 13.9 and 14.4% for the respective N levels . Applying 150 Kg N/fed recorded the tallest plants whereas the unfertized treatment gave the shortest plants . Difference between 100 and 150 Kg N/fed was not significant in the 2nd season only . It is quite evident from the present data that N has a prominent role on maize growth expressed in terms of plant height . The vital role of N and its necessity for protoplasm formation, photosynthesis activity, cell division and merestimatic activity in plant organs is clearly illustrated .

Similar results were reported by **El-Hosary, and Salwau, (1989) ; Younis et al.(1995) ; Badr et al .(1997) ; Faisal et al. (1997) and Nofal, (1998).** On the other hand, **Salwau and Shams El-Din, (1992)** found that plant and ear height were not significantly increased by increasing N levels from 60 to 150 Kg N/fed .

2.2- Ear height :

Data recorded in Table (7) clearly indicate the significant differences between the mean values of ear height by adding N levels . The highest values (143.6 cm in 1996 seasons and 147.1 cm in 1997 season) were obtained by 150 Kg/fed level . Whereas, the lowest values (123.5 cm in the 1st season and 138.9 cm in the 2nd season) were obtained by the check treatment . Difference between 100 and 150 Kg N/fed in the 2nd season was not significant. These results agree with those obtained by **Younis et al . (1995) ; Badr et al. (1997) ; Faisal et al . (1997) and Nofal, (1998).**

2.3- Stem diameter :

Data in Table (7) showed that stem diameter was significantly increased by increasing N levels up to 150 Kg N/fed compared with the unfertilized treatment . This was true in both seasons . Difference between 100 and 150 Kg N/fed was not significant in both seasons. The highest values (3.44 , 3.11 cm) were obtained by 150 Kg N/fed and the control treatment gave the lowest values (2.20 , 2.15 cm) in the first and second seasons , respectively .

2.4- Number of green and dry leaves per plant :

Results indicated no significant effect on number of green leaves per plant due to N fertilizer levels in both growing seasons(Table 7) . The higher N level (150 Kg N/fed) gave the highest value and the lowest one was obtained by the control treatment . On the other hand, number of dry leaves/plant significantly decreased as N level increased up to 150 Kg/fed However, the difference between 100 and 150 Kg N/fed were not significant . This was true in both seasons . Protein formation ,nucleotide and nucleo proteins depends on N, therefore N deficiency hinders metabolism and meristemic activity in plant organs. Nitrogen is mobile in plant and it translocate to meristemic tissues so a deficiency is first in older leaves and reduced dry matter in plant organs **(Gardner et al.,1985)** .

Similar results were obtained by **Tantawy, (1983)** who found that number of green leaves/plant was not affected by N application . On the other hand , **Gouda et al. 1992 ; El-Sheikh, 1993 and Badr**

et al. 1997 who found that applying 135 Kg N/fed significantly increased number of green leaves/plant compared with other levels .

2.5- Ear leaf area and leaf area index :

The results revealed that N application significantly increased ear leaf area in both season(Table 7).Adding 150 Kg N/fed produced the highest ear leaf area . Difference between 100 and 150 Kg N/fed were not significant. This was true in both seasons . Application of 50 , 100 and 150 Kg N/fed increased ear leaf area over the control treatment by 21.6 , 41.5 and 47.5% in the 1st season and by 13.1 ,41.3 and 42.3 in the 2nd season , respectively . On the same line , leaf area index significantly increased with increasing N levels . Application of 150 KgN/fed gave the highest values. However, the check treatment gave the lowest value in both seasons. These results may be due to the vital role of N on the vegetative growth . the encouraging effect of N on the vegetative growth of maize plant is clearly illustrated . The results are also indecated the important role of N in building up the photosynthetic apparatus . Similar results were also obtained by **Gouda et al . (1992)** who found that N application up to 150 Kg N/fed caused a significant increase in leaf area/plant . **Nofal, (1994)** showed that area of topmost ear leaf was significantly increased with the increase of N level from zero to 80 , 105 and 130 Kg N/fed .

2.6- Fresh weight of different plant organs :

The effect of N treatments on the fresh weight of leaves, stems and ear per plant and total fresh weight/plant are shown in Table (7).

It was evident that the differences between all N levels were significant . The higher N level (150KgN/fed) gave the highest value and the lowest one was obtained by the unfertilized treatment . This was true in both seasons . Application of 50 , 100 and 150KgN/fed significantly increased total fresh weight per plant compared with the control treatment . These increases over the control treatment were 40.1 , 67.1 and 76% in the 1st season and by 36.9 , 71.1 and 75.5% in the 2nd season , respectively . The same trend was obtained in the other different plant organs of maize (Table, 7) . It was clearly that fresh weight of different plant organs at 80 days from planting increased by increasing N levels due to the increase in plant height, stem diameter, ear leaf area and leaf area index . Also, the increment of plant fresh weight by increasing N doses may be due to the role of N fertilizer in improving vegetative growth by increasing cell division as well as elongation of cells **(Thompson and Troeh, 1980 and Marschner, 1986) . Badr et al . (1997)** recorded that application of 135KgN/fed produced the highest values of fresh and dry weight of different plant organs . On the other hand , **Salwau, (1985)** found that the fresh and dry weight of stem and leaves /plant at 75 days after sowing were not significantly affected by increasing N level up to 120 Kg N/fed .

2.7- Dry weight of different plant organs :

Results in Table (7) indicated that N fertilization treatments had a significant effect on dry weight of leaves , stems and ear per plant as well as total dry weight/ plant . Application of 150KgN/fed produced the highest dry weight of the different plant organs of

Maize when compared with the other N levels . The difference between 100 and 150 Kg N/fed. were not significant . This was true in both seasons . Application of 50, 100 and 150 Kg N/fed. results in a significant increase in total dry weight over the check treatment by 41.8 , 73.2 and 79.3 g in 1996 season and by 41.0, 75.5 and 82.7 g in 1997 season , respectively . These results indicated that the effect of N fertilizer on accumulating dry matter may be attributed to increasing photosynthetic area which resulted in increasing photosynthetic gains **(Thompson and Troeh, 1980)** . Such increases due to N application and these results agree with those obtained by **Abdel- Aziz et al . (1986) and Badr et al . (1997)** .

Generally, the results reported positive effect of N application in enhancing growth characters of maize, such as, plant and ear height, stem diameter, number of green leaves /plant, ear leaf area, leaf area index and fresh and dry weight of different plant organs as well as the decrease in number of days to tasseling and silking dates . On the other side, application of 100 Kg N/fed. caused a significant increase in some growth characters when compared with the other N levels . Difference between 100 and 150 Kg N/fed. were not significant in most growth characters in both seasons .

3- Grain yield components

Data for the effect of N fertilizer level on the number of ears /plant , ear length, ear diameter, number of kernels/ row, number of rows/ ear, ear weight , kernels weight/ ear , grain yield per plant, 100-kernel weight and shelling % in 1996 and 1997 seasons are shown in Table (8) .

Table (8) : Effect of N fertilizer levels on grain yield components of maize in 1996 and 1997 seasons .

Characters N- levels (Kg/fed)	No. of ears / plant	Ear length (cm)	Ear diameter (cm)	No. of kernels/row	No. of rows/ ear	Ear weight (g)	Kernels weight/ ear (g)	Grain yield/ plant (g)	100-kernel weight (g)	Shelling %
1996 season										
0	0.98 a	10.80 a	3.26 a	34.0 a	12.60 a	170.3 a	136.9 a	134.6 a	33.3 a	78.4 a
50	1.01 b	12.40 b	4.07 b	38.3 b	12.80 b	180.6 b	149.8 b	151.1 b	36.2 b	80.9 b
100	1.05 c	14.30 c	4.37 c	42.6 c	13.30 c	197.0 c	169.3 c	178.4 c	40.0 c	83.8 c
150	1.06 c	14.50 c	4.50 c	43.6 c	13.50 c	198.5 c	171.1 c	182.0 c	41.6 c	84.2 c
1997 season										
0	0.96 a	11.80 a	3.62 a	33.3 a	12.90 a	165.4 a	134.2 a	129.4 a	32.3 a	79.1 a
50	1.00 b	13.60 b	4.26 b	40.4 b	13.70 b	174.6 b	145.2 b	144.6 b	38.3 b	81.1 b
100	1.05 c	15.60 c	4.70 c	44.3 c	14.50 c	187.0 c	160.5 c	168.8 c	41.6 c	83.8 c
150	1.05 c	16.20 c	4.88 c	44.9 c	14.70 c	188.1 c	162.0 c	170.8 c	42.4 c	84.1 c

3.1- Number of ears per plant :

The results in Table (8) showed that N level significantly affected number of ears/ plant in both seasons . Application of 50 , 100 and 150 Kg N/fed significantly increased ears number/ plant over the check treatment by 3.1 , 7.1 and 8.2% in the 1st season and by 4.2 , 9.4 and 9.4% in the 2nd season, respectively . Applying 150 Kg N/fed gave the highest values. Whereas , the control treatment recorded the lowest values in both seasons . Difference between 100 and 150 Kg N/fed were not significant. This was true in both seasons. The present results indicates clearly that N fertilizer reduced number of ears/ plant which is observed in the check treatment , and also increased number of two eared / plants in maize. Similar results were also reported by **Nofal, (1994) ; El-Sheikh, (1998 a) and Faisal and Shalaby, (1998)** who recorded significant response in number of ears/ plant to variable levels of N application.On the other hand , **Faisal et al. (1997)** reported that number of ears/ plant was not significantly influenced by increasing N levels .

3.2- Ear length :

Results showed that the differences among the average values of ear length as affected by N fertilizer levels were significant in the two experimental seasons Table (8). Adding 50 , 100 and 150 Kg N/fed significantly increased ear length by 14.8 , 32.4 and 34.3% in the 1st season and by 15.2 , 32.2 and 37.3% in the 2nd season , respectively . Applying 100 or 150 Kg N/fed recorded the highest ear length, whereas the control treatment gave the lowest values . This was true in both seasons . These results may be due to the role

of N as an essential element in building maize ears due to its effect on photosynthetic activity in plants and to its positive effects on maize growth . Similar results were obtained by **Salwau, (1993) and Abdel-Samie,(1994) . Badr et al.(1997)** showed that application of 135 Kg N/fed significantly increased ear length and diameter . Whereas, **Salwau and Shams El-Din, (1992)** showed that ear length was not affected by N fertilization .

3.3- Ear diameter :

Data in Table (8) showed that the increase in N level significantly affected ear diameter in both seasons . Applying 50 , 100 , 150 Kg N/fed significantly increased ear diameter over the check treatment by 24.8 , 34 and 38% in the 1st season and by 17.7 , 29.8 and 34.8 % in the 2nd season , respectively. However, difference between 100 and 150 Kg N/fed was not significant . This was true in both seasons. The increase in ear diameter followed the same pattern as that obtained with ear length . The effect of application high levels of N on ear size is clearly demonstrated . Similar results were obtained by **Salwau, (1993) and Abdel-Samie, (1994) . Badr et al. (1997)** found that the increase in N level increased markedly ear diameter . On the other hand, **Abdel-Gawad et al .(1984)** reported that ear diameter of maize was not affected by increasing N levels .

3.4- Number of kernels /row :

Results showed that the differences among the average values of number of kernels/ row as affected by N fertilizer levels were significant in the two experimental seasons (Table, 8) . Applying 50 , 100 and 150 Kg N/fed significantly increased number of kernels

per row by 12.6 , 25.3 and 28.2% in the 1st season and by 21.3 , 33.0 and 34.8% in the 2nd season , respectively . Application of 150 Kg N/fed. gave the highest number of kernels /row , whereas the control treatment recorded the lowest value . However,the difference between 100 and 150 Kg N/fed. was not significant . This was true in both seasons . Application of N fertilizer increased number of kernels/ row and this may be due to the pollination and fertilization increase of maize plants . It could be concluded that N fertilization earlied tasseling and silking dates and increased photosynthetic , dry matter content and ear length . Similar results were obtained by **Salwau, (1993) . Abdel-Samie, (1994) and El-Sheikh, (1998 a)**who found that number of Kernels/row increased by increasing N level up to 120 Kg N/fed..

3.5- Number of rows/ear :

Application of 50 , 100 and 150 Kg N/fed. significantly increased the number of rows/ ear in 1996 and 1997 growing seasons (Table, 8) . Applying N levels increased this character over the control treatment by 1.6 , 5.5 and 7.1% in 1996 season and by 6.2 , 12.4 and 14% in 1997 season , respectively . Difference between 100 and 150 Kg N/fed. was not significant . This was true in both seasons. These results may be due to the role of N in seed formation and plant growth . Similar results were obtained by **Salwau, (1993) and Badr et al. (1997)** who found that adding 90-135 Kg N/fed. resulted in increasing significantly the number of rows/ ear . on the other hand **El-Sheikh, (1993)** indicated that N fertilizer had no significant effect on the number of rows/ ear .

3-6- Ear weight :

The increase in N level resulted in a significant increase in ear weight in both seasons (Table, 8) . Application of 50 , 100 and 150 Kg N/fed. significantly increased ear weight over the control by 6 , 15.7 and 16.6% in the 1st season and by 5.6 , 13 and 13.7% in the 2nd season, respectively. Applying 150 Kg N/fed. gave the highest ear weight, while the unfertilized treatment recorded the lowest value . Difference between 100 and 150 Kg N/fed. were not significant in both seasons . Increased ear weight as a result of adding N level may be due to the increase of ear length , ear diameter , number of kernels/row and number of rows/ear. These results indicate the vital role of N in forming and building up heavy maize ears . Also , The accumulation of synthesized metabolites resulted in increasing th dry matter accumulation and finally high ear weight , similar results were also reported by **Gouda et al. (1992); Salwau, (1993) ; Abdel-Samie, (1994) and Nofal, (1994) and Badr et al. (1997)** who found that the increase in N application level significantly increased ear weight of maize .

3.7- Kernels weight/ Ear

Data in Table (8) showed that kernels weight of ear was significantly increased with increasing N levels up to 150 Kg N/fed. This was true in both seasons . However, the difference between 100 and 150 Kg N/fed. was insignificant . Similar findings were obtained by **Abdel-Samie, (1994) ; Nofal, (1994) and Badr et al. (1997)** who found that application of 135 Kg N/fed. significantly increased

kernels weight/ear over the control treatment by 154.6% . However , the difference between 90 and 135 Kg N/fed was insignificant .

3.8- Grain yield/ plant :

Data on the grain yield/ plant of maize as affected by N fertilizer levels in 1996 and 1997 seasons are shown in Table (9) .

Application of 50 , 100 and 150 Kg N/fed significantly increased grain yield/plant over the check treatment by 12.3 , 32.5 and 35.2 % in the 1st season and by 11.7 , 30.4 and 32% in the 2nd season , respectively . Applying 150 Kg N/fed recorded the highest values (182 , 170.8 g) while, the unfertilized treatment recorded the lowest values (134.6 , 129.4g) in the 1st and 2nd season, respectively . However, the difference between 100 and 150 Kg N/fed were not significant . This was true in both seasons Increased grain yield/plant as a result of adding N level may be due to the increase in number of ears/plant, ear weight and kernel weight/ear . Similar results were also obtained by **El-Sheikh, (1998 a)** who recorded the highest values of grain yield/ plant due to adding 120 Kg N/fed .

3-9-100-kernel weight :

Application of N significantly increased 100-kernel weight in both seasons (Table, 8). Applying 50 , 100 and 150 Kg N/fed significantly increased 100-kernel weight over the control treatment by 8.7,20.1 and 24.9% in 1996 season and by 18.6 , 28.8 and 31.3% in 1997 season , respectively . Difference between 100 and 150 Kg N/fed were not significant in both seasons . These results may be due to the encouraging effect of N on growth characters, ear size and grain formation . Similar results were also reported by **Gouda et al.**

(1992) and El-Sheikh, (1993) who found that 100-kernel weight increased by increasing N levels up to 80 - 120 Kg N/fed. On the other hand , **Tantawy, (1983) and Abdel-Gawad et al. (1984)** indicated that 100-kernel weight was not affected by N levels .

3-10- Shelling percentage :

The results in Table (8) showed that the increase in N level significantly increased shelling percentage in both season . The results indicated that all levels of applied N caused a significant increase in shelling % , but no significant difference could be detected between 100 and 150 Kg N/fed. level .

Application of 150 Kg N/fed. significantly produced the highest shelling percentage(84.2 , 84.1%)in the 1st and 2nd seasons, respectively . Similar results were obtained by **Salwau, (1993)** and **Nofal, (1994).** They found that the increase in N level up to 130 Kg N/fed. significantly affected shelling percentage in both seasons .

On the other hand , **Abdel-Hameed, (1997)** reported that shelling percentage was not affected by various N levels .

It could be concluded that , application of 100 or 150 Kg N/fed. produced the highest values of plant growth and grain yield components asserting the vital need for N application to maize production .

4: Grain, straw and biological yield/ fed. :

Results on the effect of N levels on grain, straw and biological yields of maize are presented in Table (9) .

4-1- Grain yield (Kg/fed.) :

Data on grain yield of maize as affected by N fertilizer levels in 1996 and 1997 seasons are shown in Table (9) Application of 50 , 100 and 150 Kg N/fed. significantly increased grain yield over the check treatment by 26.1 , 52.7 and 54.4% in the 1st season and by 23, 47.2 and 49% in the 2nd season, respectively . Applying 150 Kg N/fed. recorded the highest grain yield (3111 , 3110 Kg/fed.) while , the unfertilized treatment gave the lowest grain yield (2015 , 2087 Kg/fed.) in the 1st and 2nd seasons, respectively . The difference between 100 and 150 Kg N/fed. were not significant in both seasons . The increase in grain yield due to the application of higher rate of N may be attributed to the increase in stem diameter, dry matter accumulation of different plant organs, ear leaf area , ear size , number of rows , weight of 100-kernel , ear weight , grain yield/plant and shelling percentage . Also, these results indicate clearly that the vital role of N in plant growth and its contribution in increasing the grain yield . It could be concluded that N is essential for cell division and elongation as well as the root growth and dry matter content of maize plant . Similar results were obtained by **El-Hosary and Salwau, (1989) ; Gouda et al. (1992); Nofal, (1994) and Tollenaar et al. (1994)** .Also, the same trend was obtained by **Rees et al. (1996); Abdel-Hameed,(1997);Badr et al. (1997) Ulger et al. (1997); El-Sheikh, (1998 a) . Nofal, (1998)** on calcareous soil , the highest N level 135 Kg N/fed. induced an increase in grain yield of 146 and 200% in the 1st and 2nd seasons, respectively . On the other hand , **Shalaby et al (1990)** recorded that N fertilizer level did not induce any change in grain yield in both seasons.

Table (9) : Effect of nitrogen fertilizer levels on grain, straw and biological yield of maize in 1996 and 1997 seasons .

Characters N-levels (kg/ fed)	Grain yield (kg/ fed)	Straw yield (kg/fed)	Biological yield (kg/fed)
1996 season			
0	2015 a	2505 a	4520 a
50	2541 b	3759 b	6300 b
100	3076 c	4464 c	7540 c
150	3111 c	4619 c	7730 c
1997 season			
0	2087 a	2743 a	4830 a
50	2566 b	4284 b	6850 b
100	3072 c	4718 c	7790 c
150	3110 c	4930 c	8040 c

4-2- Straw yield (Kg/fed) :

Results showed the differences among the average values of straw yield as affected by N fertilizer levels in both experimental seasons (Table, 9) . Application of 150 Kg N/fed produced the highest straw yield/fed (4619 , 4930 Kg) compared with the check treatment which gave the lowest straw yield (2505 , 2743 g) in the 1st and the 2nd seasons , respectively . But , the difference between 100 and 150 Kg N/fed were not significant . This was true in both

seasons . Nitrogen fertilization improving vegetative growth by increasing cell division as well as cells elongation . Similar results were obtained by **El-Kholy, (1987); Ahmed, (1990) and Amin, (1994)** who found that application of 105 Kg N/fed. produced the highest values of straw yield compared with the other N levels in both season .

4-3- Biological yield (Kg/fed.)

Results of the effect of N levels on biological yield in 1996 and 1997 seasons are shown in Table (9) . Application of 50 , 100 and 150 Kg N/fed. resulted in a significant increase in the biological yield over the control treatment by 39.4 , 66.8 and 71% in 1996 season and by 41.8, 61.3 and 66.5% in 1997 season , respectively . Difference between 100 and 150 Kg N/fed. were not significant . This was true in both seasons . These results may be due to the increase in plant growth, grain yield and its components as well as straw yield by increasing N levels (Tables 7, 8 and 9) . This shows a necessity for N to obtain enhanced plant growth . Similar results were reported by **Attia, (1988); Ahmed, (1990) and Amin, (1994)** . On the other hand , **El-kholy, (1987)** indicated that biological yield was not significantly affected by increasing N levels .

5- Chemical composition :

The effect of N fertilization levels (0 , 50 , 100 and 150 Kg N/fed. on the chemical composition of maize grains through the two growing seasons are presented in Table (10) .

Table (10) : Effect of N fertilizer levels on chemical composition in grains of maize in 1996 and 1997 seasons .

Characters N-levels (Kg/fed)	N %	C. P %	Absolute amount of N (Kg/fed)	P %	Absolute amount of P (Kg/fed)	K %	Absolute amount of K (Kg/fed)	Total * carbohydrate %	Absolute amount of carbohydrate (kg/fed)
1996 season									
0	1.80 a	11.25 a	36.27 a	0.24 a	4.83 a	0.35 a	7.1 a	79.70 a	1606 a
50	1.80 a	11.25 a	45.74 b	0.26 a	6.61 b	0.42 a	10.7 b	76.80 a	1951 b
100	1.83 a	11.44 a	56.30 c	0.27 a	8.31 c	0.46 a	14.2 c	76.10 a	2341 c
150	1.83 a	11.44a	56.93 c	0.27 a	8.40 c	0.47 a	14.6 c	73.60 a	2290 c
1997 season									
0	1.76 a	11.00 a	36.73 a	0.29 a	6.10 a	0.41 a	8.6 a	80.70 a	1684 a
50	1.77 a	11.06 a	45.42 b	0.30 a	7.70 b	0.43 a	11.0 b	79.40 a	2037 b
100	1.77 a	11.06 a	54.37 c	0.30 a	9.22 c	0.44 a	13.5 c	78.80 a	2421 c
150	1.78 a	11.13 a	55.36 c	0.31 a	9.64 c	0.44 a	13.7 c	77.80 a	2420 c

* Total carbohydrate calculated as glucose .

5-1- Nitrogen and crude protein percentages:

Results of the effect of N levels on nitrogen and crude protein percentages in maize grains in both seasons are shown in Table(10) .

Results indicated that all N treatments showed no significant effect on N and CP percentages in both seasons . It was clear that increases in N % and CP % as a results of N application were below the level of significance . Application of 150 Kg N/fed. gave the highest N% (1.83 , 1.78%): while , the unfertilzed treatment gave the lowest values (1.80 , 1.76%) in the 1st and 2nd seasons, respectively but all increases were not great enough to reach the 5% level of significance .

On the other hand , **Abdel-Hameed, (1997) and El-Sheikh, (1998 b)** reported that grain N content were increased by increasing nitrogen levels .

5-2- Absolute amount of nitrogen in grain :

Data in Table (10) showed that Nitrogen fertilizer significantly increased N uptake in both seasons . Application of 50 , 100 and 150 Kg N/fed. increased nitrogen yield over the check treatment by 26.1 , 55.2 and 57.0 % in the 1st season and by 23.7 , 48.0 and 50.7 % in the 2nd season , respectively . Applying 150 Kg N/fed. gave the highest N uptake (80.2 , 77.5 Kg/fed.) .However, the unfertilized treatment recorded the lowest values (50.8 , 51.3) in the 1st and 2nd seasons, respectively. Difference between 100 and 150 Kg N/fed. was not significant . This was true in both seasons . These increases

may be due to the significance increasing in grain yield . Similar results were reported by **Nofal, (1994) and El-Sheikh, (1998 b) . Rees et al. (1996)** reported that the fertilizer N levels had significant effect on total N uptake . On the other hand , **Sisson et al. (1991)** showed that N uptake decreased as fertilizer N increased up to 90 Kg N/fed .

5-3- Phosphorus percentage (%) :

Application of nitrogen levels had no significant effects on p% in grains in both seasons (Table, 10) . Application of 150 Kg N/fed gave the highest phosphorus percentage .While, the check treatment gave the lowest value . The increase in P% as a results of N application were below the level of significance . Similar results were obtained by **Nofal, (1998)** who showed that slight increases were below the level of significance .

5-4- Absolute amount of phosphorus :

The effect of N fertilizer levels on absolute amount of phosphorus in grains throughout 1996 and 1997 seasons are presented in Table (10) . Application of N levels (50, 100 and 150 Kg N/fed) significantly increased phosphorus uptake by 36.8 , 72.0 and 73.9 % in 1996 season and by 26.2 , 51.1 and 58.0 % in 1997 season , respectively . Applying 150 Kg N/fed gave the highest P uptake , while the control treatment recorded the lowest one . However , the difference between 100 and 150 Kg N/fed were not significant in both seasons. These increases may be due to the significance increasing in grain yield .

5-5- Potassium percentage :

The results in Table (10) showed that the increase in N levels had no significance difference in k% in grains in both seasons . The results showed that slight increases in K% was obtained by increasing N levels, but these increases were below the level of significance . The present results did not agree with those reported by **Nofal, (1994) ; Abdel-Hameed , (1997) ; Badr et al.(1997); El-Sheikh, (1998 b) and Nofal, (1998)** who found that the increase in N levels increased K % in maize kernels .

5-6-Absolute amount of potassium :

The effect of N fertilizer levels on absolute amount of K in 1996 and 1997 seasons are presented in Table (10) . Application of 50 . 100 and 150 Kg N/fed. significantly increased absolute amount of K in both seasons . Applying 150 Kg N/fed. gave the highest absolute amount of K (14.6 , 13.7 Kg/fed.). While the control treatment gave the lowest values (7.1 , 8.6 Kg/fed.) in the 1st and 2nd seasons, respectively. Difference between 100 and 150 Kg N/fed. were not significant . This was true in both seasons .

5-7- Total carbohydrate percentage and absolute amount of carbohydrate (Kg/fed.) :

The effect of N levels on total carbohydrate percentage as well as absolute amount of carbohydrate/fed. in 1996 and 1997 seasons are shown in Table (10) . Differences among all nitrogen levels on total carbohydrate % were not significant in both seasons . The same trend was obtained by **Badr et al.(1997)** who found that the

differences among N levels in total carbohydrate percentage in grains of maize were not significant.

With regard to the absolute amount of carbohydrate /fed , the application of 50 , 100 , and 150 Kg N/fed levels increased absolute amount of carbohydrate over the unfertilized treatment by 21.5 , 45.8 and 42.2% in the 1st season and by 21.0 , 43.8 and 43.7 in the 2nd season , respectively. Applying 100 Kg N/fed gave the highest absolute amount of carbohydrate in the 1st season . However , application 150 Kg N/fed gave the highest value in 2nd season , but the difference between 100 and 150 Kg N/fed were not significant in both seasons. These results may be due to the increase in grain yield/fed .

A-6: Nitrogen use efficiency and apparent nitrogen recovery :

Results on the effect of N levels on nitrogen use efficiency and apparent nitrogen recovery in grains of maize are presented in Table (11) .

Table (11) : Effect of nitrogen fertilizer levels on nitrogen use efficiency and apparent nitrogen recovery in grains of maize in 1996 and 1997 seasons .

Characters N- levels(Kg/fed)	Nitrogen use efficiency	Apparent nitrogen recovery
1996 Season		
0	-	-
50	10.52 b	18.94 b
100	10.61 b	20.03 b
150	7.31 a	13.77 a
1997 Season		
0	-	-
50	9.62 b	17.38 b
100	9.85 b	17.64 b
150	6.82 a	12.42 a

6-1- Nitrogen use efficiency:

Results in Table (11) show the values of N use efficiency as affected by N fertilizer levels in 1996 and 1997 seasons . The results showed that applying 100 Kg N/fed produced the greatest N use efficiency (10.61 , 9.85 Kg) in the 1st and 2nd seasons, respectively . Application of 50 , 100 and 150 Kg N/fed gave NUE of 10.52 , 10.61 and 7.31 Kg grains/1 Kg N, respectively in 1996 season. The same respective N levels gave NUE of 9.62 , 9.85 and 6.82 Kg grains/1 Kg N in 1997 season. However, the difference between 50 and 100 Kg N/fed was insignificant . The present results indicate a great N use efficiency by applying N levels showing the importance of applying high N level for producing a high grain yield of maize . Similar results were obtained by **Mahgoub et al . (1991) and Sisson et al . (1991)** who showed that the efficiency of N use decreased as N rates were increased . On the other hand , **Nofal, (1994)** showed that NUE was increased by applying N treatment rates of 80 to 130 Kg N/fed However, **El-Sheikh, (1998a)** recorded that no difference between 60 and 120 Kg N/fed for NUE .

From the economic point of view, it is worth to indicate that the use of 100 kg N/fed would be profitable, since the price of 1 kg N is L. E. 0.64 **(according to the Official Prices announced on July*, 1st ,1998)** .

6-2- Nitrogen recovery (N R C) :

The results indicated that the highest recovery percentage was recorded by applying 100 Kg N/fed (28.3 , 25.6%). However,

*Official Prices declared by the Egyptian Agricultural Credit and Development Bank on the first of July,B. (1998).

applying 150 Kg N/fed gave the lowest values (19.6 , 17.5%) in the 1st and 2nd seasons, respectively . Application of 50 , 100 , 150 Kg N/fed gave NRC of 26.8 , 25.6 and 17.5% . However, the difference between 50 and 100 Kg /fed was insignificant in both seasons . **El-Sheikh, (1998 b)** found that fertilization with N showed progressed increase up the rate of 120 Kg N/fed which gave the highest increase of 22.55% for nitrogen recovery in grain . The higher rate of 160 Kg N/fed gave less increase of 19.17% for N recovery in grain . The same trend was also reported by **Nofal, (1998)** who showed that N recovery has been slightly reduced as the N level increased on the average of both seasons .

7- Chemical analysis of the clay soil of the experiment :

The results in Table (12) showed that the application of nitrogen treatments had no significant effect on organic matter, N, and k percentages in clay soil at harvest of maize . For example, organic matter % increased slightly as a result of these nitrogen levels . The results showed that adding 150 Kg N/fed produced the highest organic matter (2.12 , 2.07 %) while , the control treatment had the lowest values (2.03 , 2.01 %) %) in the 1st and 2nd seasons, respectively. However these differences were below the level of significance . Also, nitrogen percentage of the soil of the experiment showed slight increase at all nitrogen treatments in both seasons . Application of 150 Kg N/fed treatment recorded the highest N percentage in soil (0.230 , 0.240 %), However , the check treatment gave the lowest values (0.228 , 0.230%) %) in the 1st and 2nd seasons, respectively. But , these difference were below the level of significance . The present results may be attributed to the fast

decomposition in organic sludge in the soil during summer season . The same trend was also obtained in phosphorus and potassin percentages in the soil at harvesting date of maize .

Table(12):Effect of nitrogen levels on chemical analysis of the clay soil of the experiment at maize harvest in 1996 and 1997 season .

Characters N-levels(Kg/fed)	Organic matter (%)	N %	P %	K %
1996 season				
0	2.030 a	0.228 a	0.170 a	0.050 a
50	2.070 a	0.229 a	0.175 a	0.051 a
100	2.110 a	0.230 a	0.179 a	0.052 a
150	2.120 a	0.230 a	0.180 a	0.053 a
1997 season				
0	2.010 a	0.230 a	0.200 a	0.046 a
50	2.050 a	0.230 a	0.202 a	0.051 a
100	2.060 a	0.230 a	0.214 a	0.052 a
150	2.070 a	0.240 a	0.225 a	0.052 a

B- Effect of Biogas sludge (BS):

Averages of tasseling and silking dates, growth characters, grain yield , yield components and chemical composition of grains as affected by Biogas sludge treatments in 1996 and 1997 season are shown in Tables (13 , 14 , 15 , 16 , 17 , 18 and 19) .

1- Days to tasseling and silking :

The effect of Biogas sludge on tasseling and silking dates of maize in 1996 and 1997 seasons are shown in Table (13). Results

showed that tasseling and silking dates were significantly affected by Biogas sludge levels in both seasons . Application of 5 m^3 Biogas sludge/fed significantly earlied tasseling and silking dates (1.9 & 4.8 days) %) in the 1st and 2nd seasons, respectively compared with the control treatment These results may be due to the Biogas sludge contains available nutrients and C/N ratio may be suitble for earliest tasseling and silking dates . Similar results were obtained by **Ponsica et al. (1983) and Abdel-Hameed, (1997).** On the other hand, **Nofal, (1998)** found that FYM did not significantly affected tasseling and silking dates .

Table(13):Effect of Biogas sludge levels on tasseling and silking dates of maize plant in1996 and 1997 seasons .

Characters / Biogas sludge levels (m^3/fed)	Days from Plating to	
	50 % tasseling	50% silking
1996 season		
0	60.6 b	68.4 b
5	58.7 a	64.0 a
1997 season		
0	62.2 b	63.4 b
5	57.4 a	61.6 a

2- Growth characters :

The effect of Biogas sludge on growth characters of maize plant at 80 days from planting are presented in Table (14) .

2. 1- Plant height :

Data in Table (14) showed a significant effect of Biogas sludge on maize plant height in 1996 and 1997 seasons . Applying 5 m^3 Biogas sludge/fed treatment increased plant height by 17.1% in the 1st season and by 13.2 % in the 2nd season over the check

Table (14) :Effect of Biogas sludge levels on growth characters of maize at 80 days from planting in 1996 and 1997 seasons .

Characters / Biogas sludge levels(m^3/fed)	Plant height (cm)	Ear height (cm)	Stem diameter (cm)	No.of green leaves/plant	No. of dry leaves/plant	Ear leaf area (cm^2)	L. A. I.	Fresh weight (g)			Total fresh weight / plant (g)	Dry weight (g)			Total dry weight / plant (g)
								Leaves / plant	Stem* / plant	Ear / plant		Leaves/ plant	Stem* / plant	Ear/ plant	
1996 season															
0	233.4 a	130.8 a	2.56 a	11.48 a	3.24 b	577.2 a	4.2 a	108.7 a	180.5 a	146.2 a	435.2 a	36.1 a	59.1a	48.8 a	144.0 a
5	273.3 b	138.6 b	3.13 b	11.56 a	2.58 a	697.5 b	5.0 b	131.3 b	269.1 b	207.0 b	607.7 b	45.0 b	91.9 b	69.0 b	205.9 b
1997 season															
0	221.4 a	139.0 a	2.36 a	12.19 a	3.09 b	567.5 a	3.8 a	113.3 a	184.8 a	148.7 a	446.8 a	40.8 a	61.2 a	51.8 a	153.9 a
5	250.7 b	148.8 b	3.10 b	12.21 a	2.63 a	732.0 b	5.0 b	139.6 b	246.8 b	210.9 b	597.3 b	49.4 b	94.0 b	73.7 b	2171 b

* Stem/plant = stem, sheaths and tassel .

treatment . The increases in plant height due to (BS) application reached the level of significance .

These results may be due to the effect of Biogas sludge on maize growth and contents, some nutritive elements and its effects on soil characters . The present resulted were reported by **Mahmoud et al.(1984) ; Khalil ,(1992) and Faisal and Shalaby, (1998) . El-Shimi et al. (1987)** found that plant height was enhanced significantly by Biogas sludge treatments up to 90 Kg effluent N/fed.

2.2 - Ear height :

With regard to ear height , the same trend of plant height was obtained in both seasons . Ear height was affected by Biogas sludge in both seasons (Table,14). Applying 5 m^3 B S/fed significantly increased ear height by 6% over the control treatment in the 1st season and by 7.1% the 2nd season. The effect of Biogas sludge in increasing ear height is mainly due to the nutritive contents of the manure particularly N. Similar results were reported by **Faisal and Shalaby, (1998) and Nofal, (1998)** who found that application of FYM significantly increased ear height in 1995 season only.

2.3- Stem diameter :

The results in Table (14) indicated that application of 5 m^3 BS/fed significantly increased stem diameter over the check treatments by 22.3% in 1996 season and by 31.4% in 1997 season. These increases may be due to nutritive content of the Biogas sludge.

2. 4- Number of green and dry leaves per plant :

The results in Table (14) indicated that application of 5 m^3 BS/fed did not effect number of green leaves per plant in both growing seasons . Applying 5 m^3 Biogas sludge/fed treatment gave the highest number of green leaves /plant (11.56 & 12.21), while the unfertilized treatment gave the lowest values (11.48 & 12.19) %) in the 1st and 2nd seasons, respectively. These increase were below the level of significance . On the other hand, number of dry leaves/plant significantly decreased by BS/fed application. This was true in both seasons .

2. 5 - Ear leaf area and leaf area index :

Data in Table (14) indicated that application of 5m^3 BS/fed significantly increased ear leaf area over the check treatment by 20.8% in the 1st season and 29% in the 2nd season . On the other hand, applying 5 m^3 BS/fed significantly increased LAI over the control treatment by 19% in 1996 season and by 31.6% in the 1997 season . These results may be due to nutritive content of the Biogas sludge particularly N. The present results did not agree with those reported by **Khalil, (1992)** who fount that leaf area of topmost ear was not affected by FYM application in two successive seasons.

2. 6- Fresh weight of different plant organs :

The effect of Biogas sludge treatments on the fresh weight of leaves, stem and ear per plant as well as total fresh weight /plant are shown in Table (14). Application of 5 m^3 BS/fed significantly increased total fresh weight per plant compared with the control treatment. These increases over the control treatment were 39.6% in

the 1st season and by 33.7% in the 2nd season . Similar results were reported by **Mahmoud et al. (1984) and El-Shimi et al. (1987)** who found that Biogas sludge treatments either stored or fresh significantly enhanced the fresh weight of maize plants when compared to urea fertilizer and FYM as ordinary fertilization .

2. 7- Dry weight of different plant organs :

The results in Table (14) showed that Biogas sludge treatments had a significant effect on dry weight of leaves, stem and ear per plant as well as total dry weight /plant. Applying 5 m^3 BS/fed. significantly increased total dry weight /plant by 43% in 1996 season and by 41.1% in 1997 season . Similar results were obtained by **Mahmoud et al. (1984) ; El- Shimi et al. (1987) ; Abdel-Rahim et al. (1991) and Arroug, (1985)** who found that significant increases in dry matter content in the maize plants as a result of adding Biogas sludge treatments as compared with the application of ordinary FYM and urea.

Generally, application of organic manure may be increased O.M. % and available macro-and micro-nutrients in the soil and keeping them in a readily available form .

3- Grain yield components :

Data for the effect of Biogas sludge on number of ears/plant, ear length, ear diameter, number of kernels/ row, number of rows/ ear, ear weight, kernels weight/ear, grain yield/plant, 100-kernel weight and shelling percentage in two seasons are shown in Table (15).

Table (15) : Effect of Biogas sludge levels on grain yield components of maize in 1996 and 1997 seasons .

Characters / Biogas sludge levels(m^3/fed)	No. of ears / plant	Ear length (cm)	Ear diameter (cm)	No. of kernels/row	No. of rows/ ear	Ear weight (g)	kernel weight/ ear (g)	Grain yield/ plant (g)	100-kernel weight (g)	Shelling %
1996 season										
0	0.99 a	12.60 a	3.89 a	37.70 a	12.80 a	181.0 a	150.9 a	150.2 a	37.1 a	81.2 a
5	1.06 b	13.40 b	4.21 b	41.50 b	13.30 b	192.2 b	162.7 b	172.8 b	38.5 b	82.5 b
1997 season										
0	0.99 a	13.50 a	4.19 a	38.10 a	13.70 a	173.6 a	144.8 a	144.4 a	38.0 a	81.3 a
5	1.04 b	15.10 b	4.55 b	43.30 b	14.20 b	184.0 b	156.1 b	162.4 b	39.3 b	82.7 b

3-1-Number of ears per plant :

The results in Table (15) indicated that applying Biogas sludge significantly increased number of ears per plant in 1996 and 1997 seasons . These increase over the check treatment were 7% in the 1st season and 5% in the 2nd season . These increase may be due to Biogas sludge contents of nutrients and its role in improving soil properties. The present results agree with those reported by **Faisal and Shalaby, (1998)**, who found that FYM at 20 m^3/fed increased ears number /plant. On the other hand, **Khalil, (1992)** found that application FYM did not significantly affect this trait.

3- 2- ear length :

Data in Table (15) showed that Biogas sludge application significantly increased ear length of maize in both seasons . Applying 5 m^3 BS/fed significantly increased ear length over the check treatment by 6.3% in the 1st season and by 11.9% in the 2nd season . These results did not agree with **Ponsica et al. (1983); Khalil, (1992); Abdel-Hameed, (1997) and Nofal, (1998)** who found that FYM application was not influenced ear length of maize.

3-3- ear diameter :

The results in Table (15) indicated that the application of Biogas sludge significantly affected ear diameter in both seasons , Applying 5 m^3 BS/fed gave the highest ear diameter (4.21 & 4.55 cm) while, the unfertilized treatment gave the lowest values (3.89 & 4.19cm) %) in the 1st and 2nd seasons, respectively . The results cleared that the effect of Biogas sludge on yield components of

maize is lower than the effect of mineral N fertilizer due to slow release of organic N to an available form. These results agree with those obtained by **Ponsica et al. (1983) ; Khalil, (1992) ; Abdel-Hameed, (1997) and Nofal, (1998)** who found that application of FYM significantly increased ear diameter in one season only.

3-4-Number of kernels per row :

Data in Table (15) indicated a significant effect of Biogas sludge application on number of kernels/ row. Applying $5m^3$ BS/fed significantly increased number of kernels /row over the control treatment by 10.1% in 1996 season and by 13.6% in 1997 season. This increase indicates a positive effect of Biogas sludge on this trait, but this effect is not comparable to the effect of mineral N. The present results are in agreement with those obtained by **Abdel-Hameed, (1997) and Faisal and Shalaby, (1998)** who found that animal manure significantly increased number of grains /row.

3- 5- Number of rows/ear :

The effect of Biogas sludge treatments on number of rows/ear is shown in Table (15). Application of $5m^3$ BS/fed significantly increased number of rows/ear over the control treatment by 3.9% in 1996 season and by 3.6% in 1997 season. This results were obtained by **Abdel-Hameed, (1997) and Faisal and Shalaby, (1998)**. On the other hand, **khalil, (1992) and Nofal, (1998)** who found that application of FYM at 20 and 40 ton/fed had no significant effect on number of rows/ear in both seasons.

3- 6- Ear weight :

The results in Table (15) showed that Biogas sludge significantly affected ear weight in both seasons. Applying $5m^3$ BS/fed increased ear weight over the check treatment by 6.2% in the 1st season and by 6% in 2nd season. The present results show the positive effect of Biogas sludge on ear weight due to its contents of nutritive elements. The present results are mainly due to the positive effects of organic manure on the growth characters as well as on ear size of maize. Similar results were obtained by **Abdel-Hameed, (1997) and Nofal, (1998)** who recorded that FYM significantly affected ear weight in both seasons . On the other hand, **Khalil, (1992)** showed that ear weight was not significantly affected by application of FYM .

3- 7- Kernels weight /ear :

Data in Table (15) showed that kernels weight /ear significantly increased by the application of Biogas sludge. This was true in both seasons. Applying $5m^3$ BS/fed increased kernels weight /ear over the unfertilized treatment by 7.8% in 1996 season and by 7.8% in 1997 season . These results may be due to the significant increase in number of kernels /row and ear weight .

3- 8- Grain yield/plant :

Data on the grain yield /plant of maize as affected by Biogas sludge treatments in 1996 and 1997 seasons are shown in Table (15). Application of 5 m^3 BS/fed significantly increased grain yield/plant over the control treatment by 15% in the 1st season and by 12.5% in

the 2nd season . These results may be due to the significance increasing in number of ears /plant and ear weight .

3-9- 100-Kernel weight :

The results in Table (15) indicated that Biogas sludge affected 100 - Kernel weight . Application of 5 m^3 BS/fed significantly increased 100- kernel weight over the check treatment by 3.8 % in the 1st season and by 3.4% in the 2nd season .These results may be due to Biogas sludge positively affected grain index of maize due to its contents of nutrient elements and its effects on soil characters .

These results agree with those obtained by **Abdel-Hameed, (1997)** and **Faisal** and **Shalaby, (1998)** who indicated that FYM significantly increased 100-kernel weight .

3-10- Shelling percentage :

The results in Table(15) showed that Biogas sludge significantly affected shelling percentage in both seasons . Applying 5 m^3 BS/fed significantly increased shelling percentage over the check treatment by 1.6% in the 1st season and by 1.7% in the 2nd season .

These results may be due to Biogas sludge contents of the different nutrient elements . The present results are expected since Biogas sludge positively affected growth characters and yield components of maize . Similar results were obtained by **Ponsica et al. (1983)** and **Nofal, (1998)** who found that application of animal manure favored production of higher shelling percentage . On the other hand, **Abdel-Hameed, (1997)** reported that application of 25 m^3 FYM/fed did not significantly affect shelling % in both seasons .

4- Grain; straw and biological yield :

Results on the effect of Biogas sludge on grain ; straw and biological yields of maize are shown in Table (16) .

4-1: Grain yield(Kg/fed) :

Results on the effect of Biogas sludge fertilizer level(zero and 5 m^3/fed)on grain yield in 1996 and 1997 seasons are presented in Table (16) .

Table (16) : Effect of Biogas sludge on grain, straw and biological yield of maize in 1996 and 1997 seasons .

Characters Biogas sludge levels(m^3/fed)	Grain yield (kg/ fed)	Straw yield (kg/fed)	Biological yield (kg/fed)
1996 season			
0	2565 a	3601 a	6166 a
5	2807 b	4073 b	6880 b
1997 season			
0	2585 a	3935 a	6520 a
5	2833 b	4403 b	7236 b

The results indicated that grain yield of maize showed positive response to increment of Biogas sludge . Adding 5 m^3 BS/fed significantly increased grain yield over the check treatment by 9.4% in the 1st season and by 9.6% in the 2nd season . These results indicated that the positive effect of Biogas sludge on grain yield due to its contents of NPK as well as organic matter as shown in the chemical analysis of the manure(Table,2) .The present results are

expected since Biogas sludge positively increased plant height, ear height, stem diameter, number of dry leaves, ear leaf area, leaf area index, total fresh and dry weight/plant, number of ears/plant,ear length, ear diameter, number of kernels/row, number of rows/ear, ear weight , kernel weight ear, grain yield/plant, 100-kernel weight and shelling percentage consequently , an increase in maize grain yield is expected. Also, application of $5m^3$ BS/fed. earlied tasseling and silking dates . It is worth noting that the effect of mineral N is more clear than that of organic N as for as grain yield is concerned . Similar results were also obtained by **Mahmoud et al. (1984) ; El-Shimi et al. (1987); El-Koumey, (1993); Mehta et al.(1994) ; Abdel-Hameed, (1997); Faisal and Shalaby, (1998) and Nofal,(1998)** Who found that adding $40m^3$/fed. animal manure significantly increased grain yield of maize . **Jokela, (1992)** reported that maize grain yield was increased by soil manuring .

4- 2- Straw yield (kg/fed.) :

Data in Table (16) indicated that the application of Biogas sludge had a significant effect on straw yield . This was true in both seasons . Adding 5 m^3 BS/fed. significantly increased straw yield over the control treatment by 13.1% in 1996 season and by 11.9% in 1997 season . Such increase in straw yield as a result of adding 5 m^3 BS/fed. may be due to the increase in plant growth of maize plants .

4- 3- Biological yield :

The results in Table (16) showed that the application of Biogas sludge increased Biological yield in both seasons. Applying 5 m^3 BS/fed. significantly increased biological yield over the control

treatment by 11.6% in the 1st season and by 11% the 2nd season. These results are expected since Biogas sludge enhanced plant growth, grain yield, yield components and straw yield . The positive effect of Biogas manure was mainly due to the soluble components, growth regulators and trace-elements **(Arroug,1985)** .

5 - Chemical composition:

The effect of Biogas sludge(0 , 5 m^3/fed) on the chemical composition of maize grains in both seasons are presented Table (17) .

5-1 - Nitrogen and crude protein percentages :

Results of the effect of Biogas sludge levels on N and crude protein percentages in grains in 1996 and 1997 seasons are shown in Table (17) .

Results indicated that both treatments showed no significant effect on N and crude protein percentages in both seasons . It was clear that N and crude protein concentrations in grain as a results of Biogas sludge application were below the level of significance. Adding 5 m^3 BS/fed gave the highest N percentage(1.82,1.78). However, the control treatment gave the lowest values(1.81, 1.76%) in the 1st and 2nd seasons, respectively. But, all increases were not great enough to reach the 5% level of significance.

Similar results were obtained by **Abdel-Hameed, (1997)** who found that application of 25m^3 F YM/fed had no significant effect on crude protein in grain . On the other hand , **El-Sherbieny et al. (1988); Reiad et al. (1995) and Nofal, (1998)** indicated that FYM significantly increased N% in kernels in the first season only.

Table (17) : Effect of Biogas sludge levels on chemical composition in grains of maize in 1996 and 1997 seasons .

Characters Biogas sludge levels(m^3/fed)	N %	C. P %	Absolute amount of N (kg/fed)	P %	Absolute amount of P (kg/fed)	K %	Absolute amount of K (kg/fed)	Total carbohydrate %	Absolute amount of carbohydrate (kg/fed)
1996 season									
0	1.81 a	11.31 a	46.43 a	0.25 a	6.41 a	0.42 a	10.77 a	76.1 a	1952 a
5	1.82 a	11.38 a	51.09 b	0.27 a	7.58 b	0.43 a	12.07 b	77.0 a	2161 b
1997 season									
0	1.76 a	11.00 a	45.50 a	0.29 a	7.50 a	0.43 a	11.11 a	78.8 a	2037 a
5	1.78 a	11.12 a	50.42 b	0.31 a	8.80 b	0.44 a	12.46 b	79.6 a	2255 b

5-2 – Absolute amount of nitrogen :

Data in Table (17) indicated that the increase in Biogas sludge increased absolute amount of nitrogen in both seasons . Adding $5m^3$ BS/fed significantly increased absolute amount of N over the check treatment by 10.0 % in 1996 seasons and by 10.8 % in 1997 season . These results may be due to the significance increasing of grain yield of maize. Similar results were obtained by **Jokela, (1992)** who reported that maize nitrogen uptake in grain maize was increased by soil manuring .

5- 3 – Phosphorus percentage :

Application of Biogas sludge levels had no significant effects on P% in kernels in both seasons Table (17). Adding $5m^3$/fed Biogas sludge treatment gave the highest P% (0.27 & 0.31%). However, the control treatment gave the lowest percentages (0.25 & 0.29%) in the 1st and 2nd seasons, respectively. The increases in P% as a results of Biogas sludge application were below the level of significance.

5-4 – Absolute amount of phosphorus :

The results in Table (17) showed that Biogas sludge increased absolute amount of P in kernels and this increase reached the level of significance in both seasons . Applying $5m^3$ BS/fed significantly increased absolute amount of phosphorus over the check treatment by 18.2% in 1996 season and by 17.3% in 1997 season . These increase may be due to the significant increasing of grain yield .

5-5 - Potassium percentage :

The results in Table (17) showed that no significant effect was detected due to applying Biogas manure($5m^3$/fed) in both seasons .

The results showed increases in kernels due to Biogas sludge application , but these increases did not reached to level significance.

5- 6 – Absolute amount of potassium:

Data in Table (17) indicated that Biogas sludge application increased absolute amount of potassium. This was true in both seasons . Applying $5m^3$ BS/fed significantly increased absolute amount of K over the control treatment by 12.1% in the 1st season and by 12.1% in the 2nd season . The increase in absolute amount of K may be due to the significance increasing of grain yield .

5-7- Total carbohydrate percentage and absolute amount of carbohydrate (kg/fed) :

The effect of Biogas sludge levels on total carbohydrate % as well as absolute amount of carbohydrate /fed in both seasons are shown in Table (17). Difference between Biogas manure treatments (zero & $5m^3$/fed) on total carbohydrate percentage were not significant in both seasons . On the other hand, application of $5m^3$ BS/fed significantly increased absolute amount of carbohydrate /fed over the control treatment by 10.5% in the 1st season and by 10.7% in the 2nd season.

6 - Chemical analysis of the clay soil of the experiment :

The results in Table (18) showed that adding Biogas sludge had no significant effect on organic matter and NPK contents in clay

soil at harvest of maize . For example, organic matter increased slightly as a result of applying $5m^3$ BS/fed . Adding $5m^3$ BS/fed gave the highest organic matter (2.11 & 2.07%) .However, the check treatment recorded the lowest values(2.05 & 2.03%) in both seasons. But, these difference were below the level of significance. Also, N% in the soil of the experiment showed slightly increase at $5m^3$ BS/fed treatment . Application of $5m^3$ BS/fed recorded the highest N% (0.230 & 0.232%) while, the check treatment gave the lowest values (0.229 & 0.280%) in the 1st and 2nd seasons, respectively. The present results may be attributed to the fast decomposition of Biogas sludge in the soil during summer season . The same trend was obtained in P and K percentages in the soil at maize harvest . However, the differences between two Biogas sludge treatments was not significantly in P and K percentages in the soil. It could be concluded that applying $5m^3$ BS/fed produced the highest values of plant growth, grain yield, yield components and grain quality of maize.

Table (18) :Effect of Biogas sludge levels on chemical analysis of the clay soil of the experiment at harvest of maize in 1996 and 1997 seasons .

Characters Biogas sludge(m^3/fed)	Organic matter (%)	N %	P %	K %
1996 season				
0	2.050 a	0.229 a	0.171 a	0.051 a
5	2.110 a	0.230 a	0.181 a	0.052 a
1997 season				
0	2.030 a	0.228 a	0.209 a	0.049 a
5	2.070 a	0.232 a	0.211 a	0.051 a

C-Effect of the interaction between mineral N fertilizer and Biogas sludge on some growth characters at 80 days from planting :

The effect of the interaction between mineral N fertilizer and Biogas sludge treatments on some growth characters, namely stem diameter, number of green, dry leaves /plant, fresh weight of ear / plant, dry weight of stem/plant at 80 days from planting of maize were not significant in both seasons as well as fresh weight, stem and total fresh weight /plant, dry weight of leaves and ears /plant at 80 days from planting in the 2nd season were not significantly affected by mineral N fertilizer × Biogas sludge treatments.

Grain and biological yields /fed and yield components, namely, number of ears /plant, ear length, ear diameter, number of rows /ear, kernels weight ear, 100-kernel weight, kernels weight /plant in both seasons and ear weight in the 1st season were not affected by the interaction between mineral and organic fertilizer treatments . Chemical composition in grains such as, N, P, K and total carbohydrate percentages in both seasons and absolute amount of N, K and absolute amount of carbohydrate in grains in the 1st seasons were not significantly influenced by mineral N levels and Biogas sludge treatments . Consequently, the data were excluded. Generally, adding Biogas sludge with higher N levels (100 & 150 kg /fed) to this soil seemed of great importance for grain production and to improve the quality of maize grain .

1- Plant height (cm) :

Results showed that plant height in both seasons were significantly affected by N fertilizer and Biogas sludge treatments (Table,19). Data showed that the unfertilized Biogas treatment increased plant height with increasing N levels, but the difference between 50 and 100 kg N/fed in 1996 season only was not significant. Adding 5 m^3 B S /fed significantly increased plant height with increasing N level up to 150 kg N /fed. However, the difference between 100 and 150 kg N/fed. was insignificant. This was true in both seasons . Adding 150 kg N + 5m^3 B S /fed treatment had the tallest plant height (293.0 , 260.3 cm) . Whereas, the shortest plant height were (203.3 , 197.0 cm) of maize plants with no fertilizer treatment. Similar results were also reported by **Mahmoud et al.(1982)and Nofal ,(1998).**

2- Ear height (cm) :

From data presented in Table (19) its evident that ear height was significantly increased by the interaction between mineral N fertilizer and Biogas sludge levels in both seasons . The highest mean values were obtained by adding 100 or 150 kg N+5m^3 BS /fed treatments . On the other hand, the lowest values of ear length were recorded in both seasons with no mineral or organic fertilizers application .

3- Ear leaf area (cm) :

Data reported in Table (19) indicated that ear leaf area was significantly affected by increasing N and BS levels in both seasons.

Table (19) : Interaction effect of N mineral levels and Biogas sludge on some growth characters of maize in 1996 and 1997 growing seasons .

Characters	Biogas sludge (m^3/fed)	N mineral levels (kg N/fed.)							
		0	50	100	150	0	50	100	150
		Season 1996				Season 1997			
Plant height (cm)	0	203.3	238.5	240.3	251.8	197	213.8	273.8	237
	5	244.3	266.3	289.5	293.0	237.5	247.5	257.5	260.3
		L.S.D. (0.05) = 4.17				L.S.D. (0.05) = 3.8			
Ear height (cm)	0	118.5	129.5	135.5	139.5	135.8	137.5	141.3	141.5
	5	128	134.3	144.0	148.3	142.0	147.5	152.8	152.8
		L.S.D. (0.05) = 4.3				L.S.D. (0.05) = 2.03			
Ear leaf area (cm^2)	0	463.7	572	615.4	657.7	483.7	552	615.4	619
	5	542.8	651.8	808.7	826.9	562.8	631.7	863	870.5
		L.S.D. (0.05) = 53.3				L.S.D. (0.05) = 42.1			
L.A.I	0	3.6	4.2	4.2	4.8	3.2	3.7	4.2	4.2
	5	4.0	4.6	5.9	5.7	3.8	4.3	5.9	5.9
		L.S.D. (0.05) = 0.6				L.S.D. (0.05) = 0.4			
Fresh weight of leaves/plant (g)	0	66.1	106.7	125.6	136.5	75.5	114.2	129.5	134.0
	5	79.7	129.8	156.9	158.9	82.0	131.5	172.7	172.4
		L.S.D. (0.05) = 7.1				L.S.D. (0.05) = 2.75			
Fresh weight of stem / plant (g)	0	122.0	172.4	208.8	218.7	126.5	176.2	215.2	221.5
	5	196.4	267.9	295.9	316.4	184.3	217.3	292.1	293.4
		L.S.D. (0.05) = N.S				L.S.D. (0.05) = 4.3			
Total fresh weight/plant (g)	0	284.0	410.0	504.0	541.7	297.8	427	517.8	544.9
	5	430.6	592.2	691.0	717.3	417.9	553	707.1	711.2
		L.S.D. (0.05) = N.S				L.S.D. (0.05) = 9.68			
Dry weight of leaves/plant (g)	0	21.7	35.6	42.0	45.5	42.2	42.8	48.1	48.1
	5	28.5	43.3	53.3	54.9	31.9	46.0	59.3	60.5
		L.S.D. (0.05) = N.S				L.S.D. (0.05) = 2.4			
Dry weight of stem /plant (g)	0	40.5	55.9	69.1	71.1	42.5	57.9	71.2	73.4
	5	61.2	91.2	107.4	107.6	63.3	93.3	109.5	109.8
		L.S.D. (0.05) = 2.5				L.S.D. (0.05) = 2.5			
Dry weight of ears /plant (g)	0	32.4	43.8	56.9	62.3	36.2	48.2	61.3	61.6
	5	51.5	64.3	79.4	80.9	51.7	63.8	89.1	90.3
		L.S.D. (0.05) = 1.1				L.S.D. (0.05) = 2.7			
Total dry weight /plant (g)	0	94.6	135.3	168.0	178.8	102.9	148.9	180.6	183.1
	5	141.2	198.8	240.1	243.4	146.9	203.1	257.9	260.6
		L.S.D. (0.05) = 5.0				L.S.D. (0.05) = 7.6			

Results showed that the unfertilized BS treatment increased ear leaf area with increasing N levels up to 150 kg N/fed. level . However, the difference between 100 and 150 kg N/fed. was not significant. With adding $5m^3$ BS/fed. on maize plants, application of 100 or 150 kg N/fed.. level showed significant increases . This results was true in both seasons. The highest ear leaf area values (827 , 871 cm^2) were obtained by adding 150 kg N + $5m^3$ BS/fed.. treatment and the lowest values (484 cm^2) was obtained with no fertilizer application, in the 1st and 2nd seasons, respectively . Similar results were also reported by **Mahmoud et al.(1982)** and **Nofal, (1998).**

3- Leaf area index(L.A.I.):

Results in Table(19) indicated that L.A.I. was significantly increased by increasing mineral N × BS levels in both seasons . Application of 100 or 150 kg N+ $5m^3$ BS/fed. treatment produced the highest values of L. A. I. . On the other hand, the unfertilized treatment recorded the lowest values of L.A.I. . This result was true in both seasons .

4- Fresh weight of different plant organs (g) :

There was a significant interactions between mineral N and BS factors on some fresh weight of different plant organs. Adding 100 or 150 kg N + $5m^3$ BS/fed.. treatment recorded the highest fresh weight of leaves /plant in both seasons, stem and total fresh weight /plant in the 2nd season only. On the other hand, the unfertilized treatment recorded the lowest fresh weight of different plant organs in both seasons .

6-Dry weight of different plant organs (g) :

Data in Table (19) revealed that dry weight of stem and total plant in both seasons and dry weight of leaves and ear /plant in the 2nd season only were significantly affected by adding 100 or 150 + $5m^3$ BS/fed. treatment . Whereas, the unfertilized treatment recorded the lowest dry weight values in both seasons . Similar results were also reported by **Mahmoud et al. (1982)**.

2-Grain yield and yield components :

1-Number of kernels /row :

Data summarized in Table (20) indicated that mineral N × BS fertilization significantly affected number of kernels /row in both seasons . Number of kernels /row reached its highest values by using 100 or 150 kg N + $5m^3$ BS/fed. treatment . Whereas, the lowest values were obtained with the control treatment in both seasons .

2-Ear weight (g) :

Results for ear weight as affected by the interaction between mineral N × BS levels in 1997 season only are shown in Table (20) . Results showed that zero BS level increased ear weight by increasing N rate up to 150 kg N/fed.. However, the difference between 100 and 150 kg N/fed.. was not significant. With adding $5m^3$ BS/fed., response to N application was more clear than that at the zero BS level. The highest ear weight was obtained at 100 or 150 kg N + $5m^3$ BS/fed. treatment. On the other hand, the unfertilized treatment recorded the lowest values of ear weight in both seasons .

Table (20): Interaction effect of mineral N levels and Biogas sludge on yield and yield component of maize in 1996 and 1997 growing seasons .

Characters	Biogas Sludge (m^3/fed)	Mineral N levels (kg N/fed.)							
		0	50	100	150	0	50	100	150
		Season 1996				Season 1997			
No. of kernels/ row	0	33.8	35.6	40.1	41.4	33.0	36.4	41.4	41.9
	5	34.3	40.9	45.0	45.7	33.7	44.5	47.2	47.9
		L.S.D. (0.05) = 0.7				L.S.D. (0.05) = 1.23			
Ear weight	0	165.3	177.4	190.9	190.4	161.1	170.9	181.1	181.2
	5	175.3	183.9	203.2	206.5	169.8	178.4	193.0	195.0
		L.S.D. (0.05) = N.S				L.S.D. (0.05) = 2.7			
Shelling percentage	0	79.9	82.1	85.2	85.8	79.7	82.5	85.4	85.7
	5	80.9	83.8	86.6	86.7	82.5	83.5	86.2	86.5
		L.S.D. (0.05) = N..S				L.S.D. (0.05) = 0.7			
Grain yield (kg/fed)	0	1977	2486	2874	2923	2027	2518	2863	2929
	5	2054	2596	3279	3298	2147	2614	3281	3290
		L.S.D. (0.05) = 29.0				L.S.D. (0.05) = 246			
Biological yield (kg/fed)	0	4310	6150	7050	7170	4640	6500	7300	7630
	5	4730	6460	8030	8290	5030	7200	8280	8950
		L.S.D. (0.05) = 930				L.S.D. (0.05) = 1050			

3-Shelling % :

Results in Table (20) showed that the shelling % was significantly affected by the interaction between mineral N × B S levels. Results showed that at $5m^3$ BS/fed level, significant effect of N application on shelling % was detected in both seasons . The highest shelling % was obtained at 100 or 150 kg N + $5m^3$ B S /fed level and the lowest one was obtained at the control treatment in both seasons . Similar results were also reported by **Nofal, (1998)** who found significant effects of N + FYM on ear weight and shelling % in 1996 season and combined average .

4- Grain yield (kg/fed) :

Results in Table (20) and Fig. (1) revealed that the combined effect of mineral N fertilizer and Biogas sludge was significant on grain yield /fed. in 1996 and 1997 seasons . The highest values was obtained by 100 or 150 kg N + $5m^3$ BS/fed level and the lowest grain yield /fed was obtained by the control treatment. This result was true in both seasons . Similar results were also reported by **Sakr et al.(1992)** and **Nofal, (1998)** .

5- Biological yield (kg /fed) :

The response of maize plants to organic manure was greatly affected by N levels in both season . Such response was more evident as the N fertilizer level increased up to 150 kg N/fed. However, the difference between 100 and 150 kg N/fed. was insignificant. The highest biological yield /fed was obtained at 100 or 150 kg N + $5m^3$ BS /fed level, and the lowest biological yield was recorded by the unfertilized treatment. This result was true in both seasons . These results shows clearly the important role of organic manure and mineral N in plant life. Also, they are necessary for building a good root system, dry matter content and consequently increasing the absorption capacity. Similar results were also reported by **Sakr et al.(1992)** who found that adding N+FYM increased dry matter and grain yield of maize .

3-Chemical composition in grain :

1- Absolute amount of nitrogen (kg/fed) :

Results summarized in Table (21) showed that mineral N fertilizer × BS treatments significantly increased absolute amount of

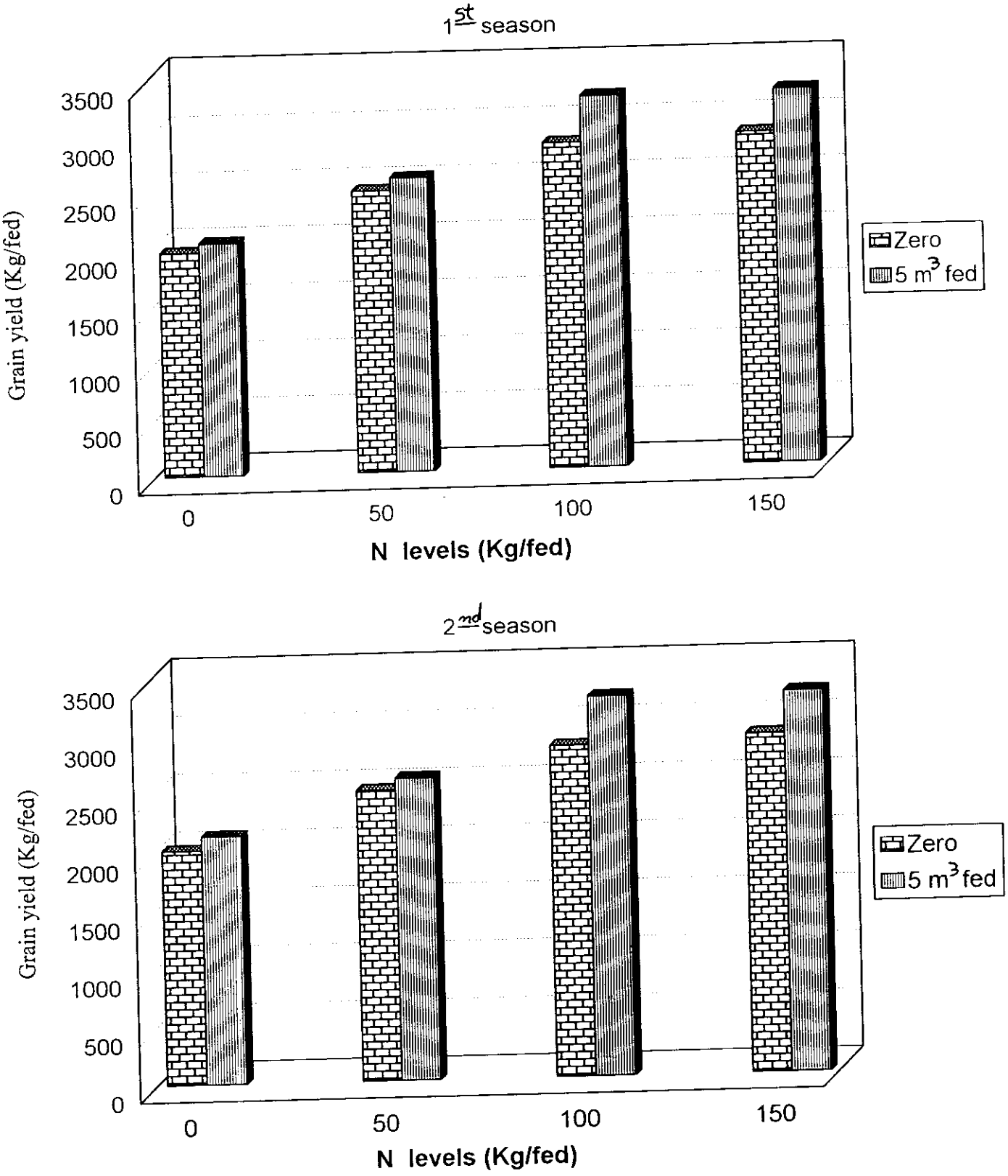


Fig.(1): Interaction effect of mineral N levels and Biogas sludge on grain yield of maize in 1996 and 1997 growing seasons .

N in grain in the 2nd season only. The highest mean values was obtained by using 100 or 150 kg N + 5m^3 BS/fed treatment. Whereas, the control treatment produced the lowest absolute amount of N . The results are in harmony with those obtained by **Mahmoud et al. (1982) and Arroug, (1985)** who recorded highly significant results of NPK uptake in maize plants which were obtained from 60 kg N/fed + 2% Biogas effluent manure treatment .

Table (21) : Interaction effect of N mineral levels and Biogas sludge on chemical composition in grain of maize in 1996 and 1997 growing seasons .

Characters	Biogas sludge (m^3/fed)	N mineral levels (kg N/fed.)							
		0	50	100	150	0	50	100	150
		Season 1996				Season 1997			
Absolute amount of N	0	35.6	44.7	52.3	53.2	35.7	44.3	50.7	51.8
	5	38.0	47.0	60.3	61.0	37.6	46.3	58.1	58.9
		L.S.D. (0.05) = N.S				L.S.D. (0.05) = 1.2			
Absolute amount of P	0	4.73	6.72	7.43	7.6	5.9	7.4	8.5	8.82
	5	5.13	6.49	9.18	9.1	6.3	8.1	10.2	10.53
		L.S.D. (0.05) = 0.62				L.S.D. (0.05) = 0.46			
Absolute amount of K	0	6.3	11.2	11.8	14.9	8.1	10.8	12.3	13.2
	5	7.8	10.1	16.7	14.2	9.0	11.5	14.8	14.5
		L.S.D. (0.05) = N.S				L.S.D. (0.05) = 0.65			
Absolute amount of carbohydrate	0	1564	1917	2084	2216	1577	1989	2282	2299
	5	1648	1985	2613	2351	1794	2085	2553	2537
		L.S.D. (0.05) = N.S				L.S.D. (0.05) = 158.2			

2- Absolute amount of phosphorus (kg/fed) :

Data in Table (21) clearly showed that absolute amount of P in grain in the both seasons was significantly affected by adding mineral N × B S treatments . The highest absolute amount of P in grain was obtained by adding 100 or 150 kg N + 5m^3 BS/fed. treatment in the 1st and 2nd seasons, respectively. On the other hand, the unfertilized treatment gave the lowest absolute amount of P in

grain. These results are in full agreement with those obtained by **Arroug, (1985)** on maize plants .

3- Absolute amount of potassium (kg/fed) :

Data recorded in Table (21) indicated that absolute amount of K in grain in the 1997 season only was significantly affected by the interaction between mineral N × BS treatments . The highest mean of absolute amount of K in grain was achieved by using 100 or 150 kg N+5m^3 BS /fed level and the lowest absolute amount of K was recorded by the control treatment. . These results are in full agreement with those findings by **Arroug, (1985)** on maize plants .

4- Absolute amount of carbohydrates (kg/fed) :

Raising mineral N fertilizer × organic sludge treatments were increased absolute amount of carbohydrate in grain in the 2nd season only (Table,21) . The highest mean values was obtained by using 100 or 150 kg$_N$+ 5m^3 BS /fed treatment whereas , the lowest value was recorded with the unfertilized treatment. This was true in both seasons .

Part two : Wheat crop :

The residual effect of mineral nitrogen fertilizer and Biogas sludge on wheat yield grown under different nitrogen levels :

A- Effect of soil application of nitrogen on wheat :

Growth characters, yield components , grain yield, Biological yield, as well as chemical composition in grain yield in 1996/97 and 1997/98 seasons, are shown in Table (22, 23, 24, 25 and 26).

1- Growth characters :

Results for the effect of nitrogen levels on growth characters of wheat, namely, plant height, number of tillers/m^2 , flag leaf area, number of leaves /stem, dry weight of different plant organs and total dry weight/plant in 0.25 m^2 at 95 days from planting in both seasons are shown in Table (22) .

1-1- plant height :

Application of 30 , 60 and 90 kg N/fed significantly increased plant height over the check treatment by 4.7 , 19.9 and 28.9% in 1996/97 season and 9.7 , 17.1 and 19.3 % in 1997/98 season , respectively. It was observed that application of 90 kg N/fed produced the tallest plants. On the other hand the untreated plot recorded the shortest plants in both seasons. These results may be due to explained on the basis that nitrogen is essential for building up protoplasm and amino acids which induce cell division and increase meristematic activity. These results agree with those obtained by **Morsy, (1993); Zahran and Mosalem, (1993) and Salwau, (1994)** who found that N fertilizer levels significantly

increased plant height. However, the difference among 30, 45, 60 and 75 kg/fed were not significant.

1-2- Number of tillers /m^2 :

Data recorded in Table (22) clearly indicate that significant differences among the mean values of number of tillers/m^2 due to adding N levels. This was true in both seasons. Differences among 30, 60 and 90 kg N/fed levels were significant. It could be concluded that the application of N had positive effect on number of tillers/m^2 of wheat which indicates the vital role of N in tillering and plant growth of wheat. Similar results were reported by **Abdel-Maaboud, (1991)** and **El-Gazzar et al. (1993).**

1-3- Flag leaf area (cm^2) :

Flag leaf area significantly increased by increasing N levels in both seasons . In the 1st season, the increases in flag leaf area due to adding 30 , 60 and 90 kg N/fed over the control treatment were 15 , 24.5 and 33.6% ,respectively . The same N levels significantly increased flag leaf area by 11.3 , 24.2 and 31.4% in 1997/98 season, respectively . However, the difference between 60 and 90 kg N/fed was not significant in both seasons. It is worthy to mention that increasing flag leaf area with increasing N application reflected the important role of N in building the photosynthetic apparatus . These results agree with those obtained by **Abo-Shataia and Abdel-Gawad, (1995) and Attalah and El-Karamity, (1997).**

Table (22) : Effect of nitrogen fertilizer levels on growth characters of wheat at 95 days from planting in 1996/97 and 1997/98 seasons .

Characters N-levels (Kg/ fed)	Plant height (Cm)	No. of tillers/ (m^2)	Flag Leaf area (cm^2)	No. of Leaves/ stem	Dry Leaves weight/0.25m^2(g)	Dry stems weight/0.25m^2 (g)	Total dry weight/plant 0.25m^2 (g)
1996 / 97 season							
0	63.3 a	274 a	25.3 a	3.18 a	22.7 a	60.7 a	83.4 a
30	66.3 b	301.9 b	29.1 b	3.87 b	36.6 b	73.8 b	110.4 b
60	75.9 c	352.3 c	31.5 bc	4.43 c	40.0 c	78.7 c	118.7 c
90	81.6 d	403.3 d	33.8 c	4.56 c	60.9 d	88.9 d	149.8 d
1997 / 98 season							
0	69.0 a	277.6 a	24.8 a	3.01 a	19.8 a	57.8 a	77.6 a
30	75.7 b	312.0 b	27.6 ab	3.86 b	33.5 b	71.0 b	104.5 b
60	80.8 c	363.8 c	30.8 b	4.3 c	36.8 c	76.3 c	113.1c
90	82.3 d	411.5 d	32.6 b	4.52 c	57.9 d	85.7 d	143.6 d

1-4- Number of leaves /stem :

Data recorded in Table (22) clearly indicate that significant differences among the mean values of number of leaves /stem by adding N levels . Application of 60 or 90 kg N/fed level produced the highest number of leaves /stem . The unfertilized treatment gave the lowest ones. This was true in both seasons. The effect of N on number of leaves /stem is mainly due to the role of N as an essential nutritive element for plant height . These results agree with those obtained by **El-Salhy, (1991) and Adam, (1992)** who found that adding 80 kg N/fed caused a significant increase in number of blades/plant.

1-5- Dry weight of different plant organs /0.25 m^2 (g).

The effect of N treatments on the dry weight of leaves, stems and all plants/0.25 m^2 at 95 days from planting are shown in Table (22) . It was observed that, significant increases were observed in leaves, stems and total plants dry weights as a result of nitrogen application in both seasons. Application of 90 kg N/fed recorded the highest dry weight of plant organs/0.25m^2 . The control treatment gave the lowest weights. Differences among 30 , 60 and 90 kg N/fed level were significant. Similar results were recorded by **Adam, (1992) and Hegab, (1994)** who showed that dry weight of plant was significantly increased by increasing N from 20 to 80 kg N/fed. It was clearly that plant height, number of tillers/ m^2 ,flag leaf area, number of leaves /stem, dry weight of leaves, stems and total plants in 0.25 m^2 at 95 days from planting increased by increasing N levels.

These results may be due to the role of N fertilizer on improving vegetative growth by increasing cell division as wall as elongation of cells **(Marschner, 1986)** . The encouraging effect of N on the vegetative growth of wheat plant is clearly illustrated. The results are also good manifestation of the role of N as an essential element for all plants in general and cereals in particular.

2- Grain yield and yield components :

Data reported in Table (23 , 24) showed that average values of grain yield components, grain yield, straw yield and biological yield as well as harvest index of wheat at harvest as affected by N fertilization treatments in 1996/97 and 1997/98 seasons.

2-1-Number of tillers/ m^2 :

Application of 30, 60 and 90 kg N/fed levels significantly increased number of tillers/m^2 by 10.9, 14.3, and 20.3% in the 1^{st} season and by 14.6, 26.1 and 36.2% in the 2^{nd} season, respectively. Differences among those N levels in both seasons were significant. Application of 90 kg N/fed recorded the highest number of tillers/m^2.While, the control treatment gave the lowest number of tillers/m^2 . This was true in both seasons . Similar results were obtained by **Roshdy, and Kassem, (1988)** who found that adding 50-75 kg N/fed level increased number of tillers/m^2.

Table (23) : Effect of nitrogen fertilizer levels on grain yield components of wheat in 1996/97 and 1997/98 seasons .

Characters N – levels (Kg/fed)	No. of tillers /m2	No. of spikes/ m^2	Spike length (cm)	spike weight (g)	No. of grains/ spike	1000- grain weight (g)
1996/97 Season						
0	351.6 a	342.1 a	5.84 a	1.57 a	20.8 a	29.6 a
30	390.1 b	371.6 b	6.57 b	1.79 b	23.6 ab	31.6 b
60	402.0 c	390.2 c	6.90 bc	1.91 c	26.3 b	32.5 b
90	422.8 d	409.3 d	7.12 c	2.13 d	27.3 b	33.4 b
1997/98 Season						
0	362.0 a	359.3 a	7.54 a	2.05 a	23.6 a	38.8 a
30	415.0 b	412.0 b	8.54 b	2.30 b	25.3 ab	41.6 b
60	456.3 c	450.7 c	9.16 c	2.48 c	26.7 b	44.2 c
90	493.1 d	491.9 d	9.43 c	2.73 d	28.7 b	45.1 c

2-2- Number of spikes /m^2 :

Results in Table (23) indicated that N fertilization treatments had a significant effect on number of spikes /m^2. Application 30 , 60 and 90 kg N/fed significantly increased number of spikes /m^2 compared with the unfertilized treatment. This was true in both seasons. Increases in number of spikes / m^2 due to adding 30 , 60 and 90 kg N /fed over the control treatment were 8.6 , 14.1 and 19.6% in 1996/97 season and 14.7 , 25.4 and 36.9% in 1997/98 season, respectively . The present results indicates cleary that the increase of N level led to increase number of tillers/m^2 and consequently reflected on the number of spikes/m^2 .

Similar results were also obtained by **Roshdy and Kassem, (1988) and Abdel-Maaboud, (1991)** who showed that number of spikes/m^2 increased by increasing N level from 50 to 75 kg N/fed. On the other hand, **Mostafa, et al. (1997)** found that increasing N level up to 150 kg N/fed significantly reduced number of spikes per square meter in the two growing seasons.

2-3- Spike length :

The effect of nitrogen treatments on the spike length are shown in Table (23). Applying 30, 60 and 90 kg N/fed significantly increased spike length compared with the control treatment. This was true in both seasons. However, the difference between 60 and 90 kg N/fed was in significant. This increase in spike length may be attributed to the fact that nitrogen fertilizer encourages cell elongation and cell division. The present results are in agreement with those obtained by **El-Salhy, (1991) ; Adam, (1992) ; Abo-Warda, (1993) ; Morsy (1993) and Mohamed, (1994) .**

2-4- Spike weight :

Results showed that the differences among the average values of spike weight as affected by N fertilizer level in the two experimental seasons (Table,23). Adding 30, 60 and 90 kg N/fed significantly increased spikes weight by 14 , 21.6 and 35.6% in the 1st season and by 12.2 , 21.0 and 33.2 % in the 2nd season, respectively . Application of 90 kg N/fed gave the highest spike weight . While, the unfertilized treatment gave the lowest spike weight. The same trend of results was observed in both seasons. This result indicate clearly the role of N as a major nutritive element for wheat plants growth in this soil. It is known that N is a constituent of chlorophyll, protoplasm, RNA and DNA. Similar results were obtained by **Abdel-Maaboud, (1991) and Morsy, (1993) .**

2-5- Number of grains /spike :

Application of 30 , 60 and 90 kg N/fed produced the highest values of number of grains/spike compared with the check treatment. This was true in both seasons. Differences between the three N levels were insignificant. This increase in number of grains /spike due to adding N fertilizer may be due to the pollination and fertilization increases of wheat spikes . Similar results were obtained by **Abo-Warda, (1993) ; Mohamed, (1994) ; Mostafa et al. (1997)** who showed that number of grains per spike had increased by increasing N level from 30 to 120kg N/fed. On the other hand , **El-Salhy, (1991)** reported that number of grains per spike did not increase with increasing N level up to 90 kg N/fed .

2-6- 1000 – grain weight :

Data on the 1000- grain weight of wheat as affected by N fertilizer levels in 1996/97 and 1997/98 seasons are shown in Table (23). Nitrogen fertilizer treatments significantly increased 1000-kernel weight in both seasons. While, differences among the three nitrogen levels in the 1st season as well as between 60 and 90 kg N/fed levels in the 2nd season were insignificant . Application of 60 and 90 kg N/fed significantly increased 1000-grain weight by 9.8 and 12.8% in the 1st season and by 13.9 and 16.2% in the 2nd season, respectively . Application of N showed a similar effect as those obtained on the other yield component characteristics, and that clarify the important role of N in increasing grain plumpness. Similar results ware obtained by **Adam, (1992) and Mostafa, et al. (1997)** who increased that 1000-kernel weight significantly increased when nitrogen level increased from 30 to 120 kg N/fed .

3-Grain,straw and Biological yield/fed as well as harvest index.

3-1 Grain yield (kg/fed) :

Results on the effect of nitrogen fertilizer levels (0 , 30 , 60 and 90 kg N/fed) on grain yield in 1996/97 and 1997/98 seasons are presented in Table (24) and Fig. (2) . The results showed clearly that N fertilizer significantly increased grain yield in both seasons. Applying 30 , 60 and 90 kg N/fed increased grain yield over the control treatment by 330 , 642 , 825 kg/fed in the 1st season and by 271 , 524 and 686 kg/fed in the 2nd season , respectively . These increases correspond to 16.1 , 31.4 and 40.3% in 1996/97 season and

by 12.7 , 24.6 and 32.2% in 1997/98 season, respectively . Application of 90 kg N/fed recorded the highest grain yield compared with the unfertilized treatment . This level (90 Kg N/fed) was more effective in increasing grain yield in both seasons . The increase in grain yield due to application of 90 kg N/fed level may be attributed to the increases of plant growth , number of tillers/m^2 , number of spikes/m^2, spike weight , number of grains spike (Tables 26 and 27). The present results indicate clearly that nitrogen is one of the most important components of cytoplasm, nucleic acids, and chlorophyll. Therefore, increasing nitrogen levels increased multiplication of cells which enhances amount of metabolites necessary for building plant organs and ended in high grain yield. These results are in agreement with those obtained by **Shalaby et al. (1993) ; Mohamed, (1994) and Mostafa et al. (1997)** who indicated that grain yield increased with the increase of N fertilizer levels from 30 to 120 kg N /fed . On the other hand, **Salwau ,(1994)** found that adding 75 kg N/fed produced the highest grain yield /fed. However, no significant difference was noticed between 45 and 75 kg N/fed .

3-2 - Straw yield (kg/fed) :

Results showed that the differences among the average values of straw yield as affected by N fertilizer levels in both experimental seasons are recorded in Table(24) and Fig. (2) .

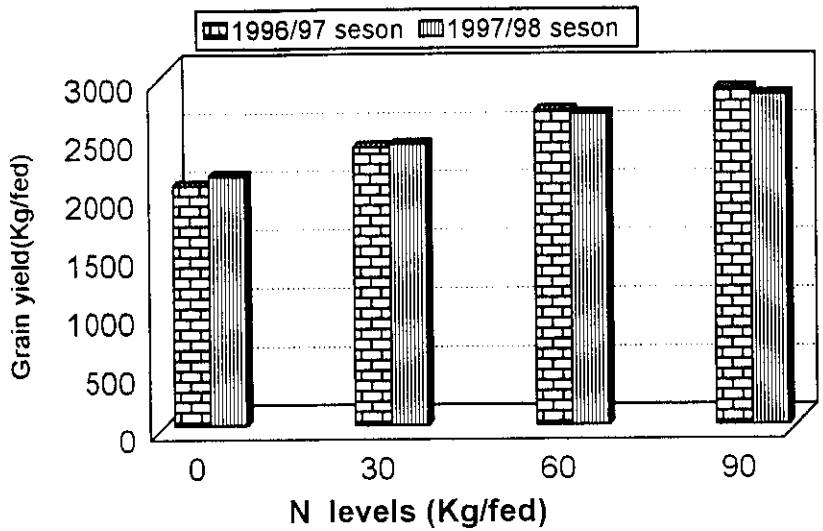
Table (24) : Effect of nitrogen fertilizer levels on grain , straw and biological yield and harvest index of wheat in 1996/97 and 1997/98 seasons .

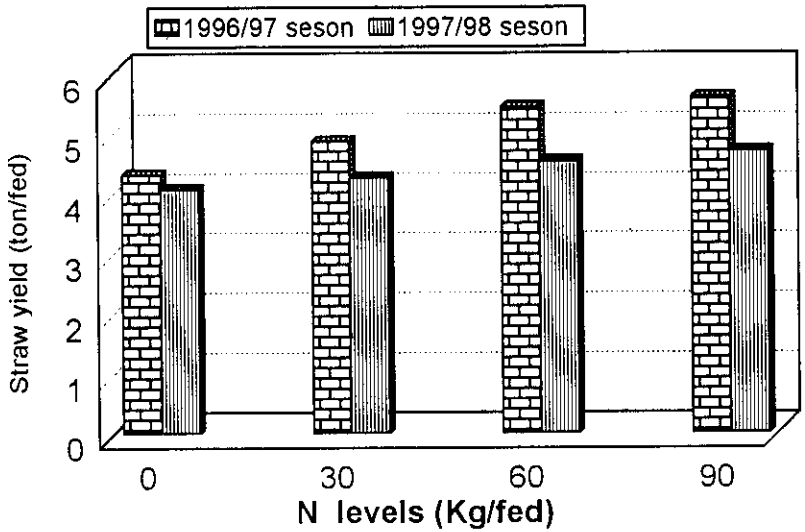
Characters N-levels (kg/fed..)	Grain yield (Kg/fed.)	Straw yield (Kg/fed.)	Biological yield (Kg/fed.)	Harvest index (%)
	1996/97 season			
0	2045 a	4315 a	6360 a	32.2 a
30	2375 b	4865 b	7240 b	32.8 ab
60	2687 c	5443 c	8130 c	33.1 b
90	2870 d	5600 d	8470 d	33.9 b
	1997/98 season			
0	2129 a	4071 a	6200 a	34.3 a
30	2400 b	4260 b	6660 b	36.0 b
60	2653 c	4537 c	7190 c	36.9 bc
90	2815 d	4705 d	7520 d	37.4 c

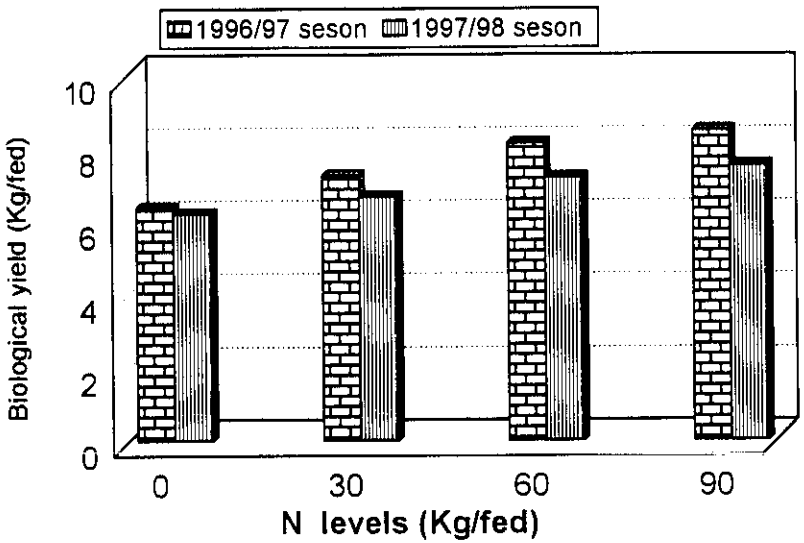
Adding 90 kg N/fed. produced the highest straw yield /fed. when compared with the check treatment. Application of 30 , 60 and 90 kg N/fed. significantly increased straw yield/fed. over the control treatment by 12.7 , 26.1and 29.8% in the 1st season and by 4.6 , 11.4 and 15.6% in the 2nd season, respectively. Nitrogen fertilization improving vegetative growth by increasing cell division as well as cells elongation **(Marschner, 1986).** Similar results were obtained by **Adam, (1992) ; Alcoz et al. (1993) and Mostafa et al. (1997)** who showed that straw yield increased with the increase of fertilizer levels from 30 to 120 kg N/fed. .

3-3- Biological yield (kg/fed.) .

Application of N rates up to 90 kg N/fed. resulted in a significant increase in biological yield in both seasons(Table,24)and Fig.(2). Increases in







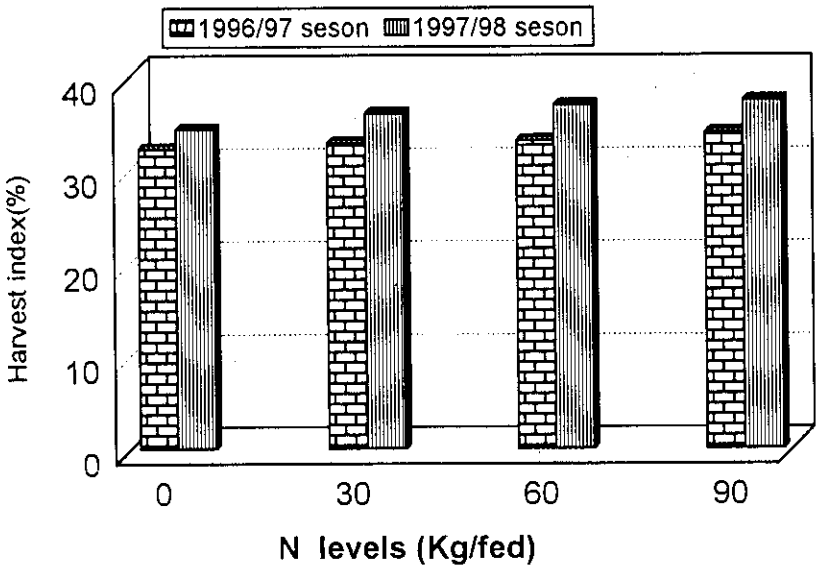


Fig.(2):Effect of nitrogen fertilizer levels on grain,straw and biological yield and harvest index of wheat in 1996/97 and 1997/98 seasons .

biological yield over the unfertilized treatment in 1996/97 season reached 13.8 , 27.8 and 33.2% at 30 , 60 and 90 kg N/fed levels , respectively . In 1997/98 season, the respective increases in this trait were 7.4 , 16.0 and 21.3% . The accumulation of synthesized metabolites results in a high dry matter accumulation and finally high biological yield /fed. These results may be attributed to the increase in plant growth, grain yield and its components as well as straw yield (Tables 22 ,23 and 24). Similar results were also reported by **Adam, (1992) ; Mohamed, (1994) and Salwau, (1994).**

3-4 – Harvest index :

It was observed that harvest index was affected due to the increase in N levels as shown in Table (24) and Fig. (2) . The highest harvest index was obtained at 90 kg N/fed level in both seasons . Data revealed that the difference between zero and 30 Kg/fed as well as among 30,60 and 90 kg N/fed were insignificant in the 1st season. Also, the difference between 60 and 90 kg N/fed in the 2nd season was insignificant. The present results agree with reported by **Mostafa et al. (1997)** who found that harvest index were significantly increased by increasing nitrogen fertilizer levels from 30 to 120 kg N/fad.

4 - Chemical composition :

The effect of N fertilization rates (0 , 30 , 60 and 90 kg N/fed) on the chemical composition in grains through the two growing seasons are presented in Table (25) .

Table (25) : Effect of nitrogen fertilizer levels on chemical composition in grains of wheat in 1996/97 and 1997/98 seasons .

Characters N-levels (kg/fed.)	N%	Crude protein (%)	Absolute amount of N (kg/fed)	P %	Absolute amount of P (kg/fed)	K %	Absolute amount of K (kg/fed	Total carbohydrates (%)	Absolute amount of carbohydrates (kg/fed)
1996 / 97 season									
0	1.75 a	9.98 a	35.8 a	.225 a	4.6 a	.421 a	8.6 a	67.2 a	1374 a
30	1.77 a	10.09 a	42.0 b	.257 b	6.1 b	.437 a	10.4 b	68.7 a	1632 a
60	1.79 b	10.20 b	48.1 c	.260 b	7.0 c	.441 a	11.8 c	70.2 a	1886 b
90	1.81 b	10.32 b	51.9 d	.266 b	7.6 d	.458 a	13.1 d	71.3 a	2046 b
1997 / 98 season									
0	1.72 a	9.8 a	36.6 a	.221 a	4.7 a	.418 a	8.9 a	72.6 a	1546 a
30	1.81 b	10.32 b	43.4 b	.268 b	6.4 b	.426 a	10.2 b	72.5 a	1740 ab
60	1.83 b	10.43 b	48.5 c	.282 c	7.6 c	.447 a	11.8 c	72.4 a	1921 b
90	1.85 b	10.55 b	52.1 d	.306 d	8.6 d	.454 a	12.8 d	75.7 a	2131 c

4-1- Nitrogen and crude protein percentages :

Results of the effect of N levels on nitrogen and crude protein concentrations in grains in 1996/97 and 1997/1998 seasons are shown in Table (25). In 1996/97 seasons, applying N at a rate of 30, 60 and 90 kg/fed significantly increased N percentage over the control treatment by 1.1 , 2.3 and 3.4 %, respectively . However, the differences between zero and 30 kg N/fed as well as between 60 and 90 kg N/fed were insignificant . In the 2nd season, application of 30 , 60 and 90 kg N/fed significantly increased N percentage over the check treatment by 5.2 , 6.4 and 7.6% ,respectively . While, the differences among the three N levels were insignificant. The same trend was obtained in CP % in grains. Application of 90 kg N/fed gave the highest protein percentage in grains. While, the check treatment gave the lowest CP percentage . The increase in N % of wheat grain by increasing N application levels could be due to the important role of N in improvement grain quality of wheat . The present results are in line with those obtained by N levels under study and agree with those reported by **Adam, (1992) ; Abo-Warda, (1993) and Morsy, (1993).**

4-2- Absolute amount of nitrogen (kg/fed) :

The response of nitrogen yield of wheat grain per fed to nitrogen application in both seasons is presented in Table (25). It was evident that nitrogen yield /fed was significantly increased by increasing N level up to 90 kg N/fed . The application of 30 , 60 and 90 kg N/fed increased the amount of nitrogen by 17.3 , 34.4 and 45.0 % in the 1st season and by 18.6 , 32.5 and 42.3% in the 2nd season, respectively. This was true in both seasons . This increase in nitrogen yield /fed

may be due to increase in grain yield /fed. and N percentage in grains. Similar result was obtained by **Abdel-Maaboud, (1991) .**

4-3- Phosphorus percentage (%) :

Application of nitrogen fertilization levels significantly increased P% in both seasons (Table,25). A higher N level (90 kg N/fed.) gave the highest P content (0.266 %, 0.306 % P in grains), whereas the unfertilized treatment gave the lowest concentration (0.225% & 0.221% P in grains). On the other hand, differences among the three N levels were not significant in 1996/97 season. These results may due to the fact that N fertilization increased root growth and the absorption of P from the soil. Similar results were obtained by **Ibrahim,(1988) and El-Salhy ,(1991) .**

4-4- Absolute amount of phosphorus (kg/fed.) :

The effect of N fertilization levels (0 , 30 , 60 and 20 kg N/fed.) on the amount of phosphorus in grains through the two seasons are shown in Table (25). Results indicated that N levels had a significant effect on the the amount of phosphorus in both seasons. Adding 30 , 60 and 90 kg N/fed. significantly increased amount of P over the control treatment by 32.6 , 52.2 and 65.2% in the 1st season and by 36.2, 61.7 and 83% in the 2nd season, respectively . Application of 90 kg N/fed. recorded the highest amount of phosphorus . While the control treatment gave the lowest values . This was true in both seasons. These results may be due to the increase in grain yield /fed. and phosphorus percentage in wheat grains.

48.9% in the 1st season and by 12.5 , 24.2 and 37.8% in the 2nd season. These results may be due to the increase in grain yield /fed . The same trend was obtained by **Badr et al. (1997)** working on maize .

5- Nitrogen use efficiency and apparent N recovery in grain :

5-1 – Nitrogen use efficiency:

Nitrogen use efficiency significantly decreased with increasing N levels (Table, 26). In 1996/97 season, applying N at 30 , 60 and 90 kg/fed gave NUE of 11.0 , 10.7 and 9.2 respectively. In 1997/98 season, the same respective N level recorded NUE of 9.0 , 8.7 and 7.6 . However, the difference between 30 and 60 kg N/fed level was not significant. This was true in both seasons. These results gave with those reported by **Sowers et al. (1994)** who found that NUE decreased 26% to 44% relative to the control (zero N applied) when 140 kg N/ha was full. applied .

From the economic point of view, it is worth to indicate that the use of 90 kg N/fed would be profitable, since the price of 1 kg N is L. E. 0.64 (**according to the Official Prices announced on July*, 1st ,1998)** .

5-2- Apparent nitrogen recovery (NRC) :

Application of 30,60and 90 Kg N/fed gave NRC of 26.3,23.7 and 20.0 % in 1996/97 season and 11.3,11.1 and 10.3% in 1997/98 season, respectively . However, the difference between 30 and 60 was insignificant in both seasons . Similar results were also reported

*Official Prices declared by the Egyptian Agricultural Credit and Development Bank on the first of July,B (1998).

by **El-Sheikh, (1998 b) and Nofal, (1998)** they working on maize .It could be concluded that under the conditions of this experiment, application of 90 kg N/fed is recommended for the yield of grain, straw and biological per fed. However, application of 30 or 60 kg N/fed recorded the highest values of NUE and N recovery .

Table (26) : Effect of nitrogen fertilizer levels on nitrogen use efficiency and apparent nitrogen recovery in grain of wheat in 1996/97 and 1997/98 seasons .

Characters N-levels (kg/fed)	Nitrogen use efficiency (NUE)	Apparent nitrogen recovery (%) (NRC)
1996/97 season		
0	-	-
30	11.0 b	26.3 b
60	10.7 b	23.7 b
90	9.2 a	20.0 a
1997/98 season		
0	-	-
30	9.0 b	11.3 b
60	8.7 b	11.1 b
90	7.6 a	10.3 a

B-The residual effect of mineral nitrogen fertilizer :

Results for the residual effect of mineral nitrogen fertilizer on growth characters, grain yield and yield components as well as chemical composition of wheat grains in 1996/97 and 1997/98 seasons, are shown in Tables (27, 28, 29 and 30).

1-Growth characters:

Vegetative growth characters of wheat, namely, plant height number of tillers /m^2, flag leaf area, number of leaves /stem and dry weight of different wheat plant organs and total dry weight /plant in 0.25 m^2 at 95 days from planting in both seasons were not affected by the residual effect of mineral N fertilizer are shown in Table (27). Results indicated that the residual effect of mineral N fertilizer levels at all treatments showed no significant effect on studied growth characters in both seasons of experimentation . It was clear that increases in all growth characters of wheat were obtained as a result of the residual effect treatments were below the level of significance. Slight increases in some characters were obtained as a result of the residual effect treatment (150 kg N/fed) .

2- Grain yield components :

Results on grain yield components of wheat as affected by the residual effect of mineral N fertilizer treatments in 1996/97 and

Table (27) : The residual effect of mineral N fertilizer on growth characters of wheat at 95 days from planting in 1996/97 and 1997/98 seasons .

Characters N levels (Kg/fed)	Plant height (cm)	No. of tillers/ (m^2)	Flag leaf area (c m^2)	No. of leaves / stem	Dry leaves weight/0.25 m^2	Dry stems weight/0.25 m^2 (g)	Total dry weight/ plant (0.25 m^2) (g)
1996 / 1997 season							
0	70.5 a	331.2 a	28.5 a	3.95 a	38.7 a	74.1 a	112.8 a
50	71.4 a	330.5 a	29.1 a	4.22 a	39.5 a	75.1 a	114.6 a
100	72.5 a	335.4 a	30.6 a	3.92 a	40.5 a	76.1 a	116.6 a
150	73.0 a	334.0 a	31.3 a	3.95 a	41.3 a	76.8 a	118.1 a
1997 / 1998 season							
0	75.4 a	339.1 a	28.1 a	3.65 a	35.7 a	71.1 a	106.8 a
50	76.8 a	340.0 a	29.8 a	3.82 a	36.5 a	72.1 a	108.6 a
100	77.4 a	341.7 a	28.4 a	4.07 a	37.5 a	73.4 a	110.9 a
150	77.9 a	344.0 a	29.4 a	4.15 a	38.3 a	74.3 a	112.6 a

1997/98 seasons are shown in Table (28) . Results showed that number of tillers /m^2, number of spikes /m^2, spike length, spike weight , number of grains /spike and 1000-grain weight of wheat were not significantly affected by application of mineral N fertilizer to maize in both seasons of experimentation . However, all growth characters were favorably affected by the residual effect treatments , where insignificant increases were observed as a result of the residual effect of N fertilizer treatments at the different levels used. For example, the number of spikes /m^2 increased slightly as a result of these residual effect treatments . Increases in number of spikes/m^2 over the control treatment were 0.1 , 0.5 and 0.8% in the 1st season and 0.3 , 0.5 and 0.8% in the 2nd season, respectively . The residual effect of 150 kg N/fed treatment gave the highest number of spike/m^2 379.8 in the 1st season and 430.2 in the 2nd season, respectively . While, the control treatment gave the lowest ones (376.8 spikes/m^2 in the 1st season and 426.8 spikes/m^2 in the 2nd season). Also, 1000-grain weight of wheat showed slight increases at all residual effect treatments in both seasons. The residual effect of 150 kg N/fed treatment recorded the highest 1000-grain weight which were 32.6 g in the 1st season and 42.5 g in the 2nd season. Whereas, the control treatment gave the lowest 1000-grain weight (30.8 g in the 1st season and 42.3 g in the 2nd season) . This was true in both seasons . The data indicate that the residual effect of mineral N fertilizer on maize are not sufficient to give high growth of wheat.

Table (28) : The residual effect of mineral N fertilizer on the yield components of wheat in 1996/97 and 1997/98 seasons .

Characters N levels (Kg/fed)	No. of tillers / m^2	No. of spikes/ m^2	Spike length (cm)	Spike weight (g)	No. of grains/ spike	1000- grain weight (g)
1996/1997 Season						
0	389.8 a	376.8 a	6.29 a	1.66 a	22.8 a	30.8 a
50	390.5 a	377.6 a	6.43 a	1.83 a	22.8 a	31.5 a
100	392.7 a	379.0 a	6.74 a	1.92 a	25.5 a	32.1 a
150	393.4 a	379.8 a	6.96 a	1.99 a	26 a	32.6 a
1997/1998 Season						
0	428.9 a	426.8 a	8.62 a	2.23 a	25.5 a	42.3 a
50	340.0 a	427.9 a	8.50 a	2.45 a	25.9 a	42.4 a
100	433.2 a	429.0 a	8.65 a	2.40 a	26.2 a	42.4 a
150	434.2 a	430.2 a	8.90 a	2.48 a	26.6 a	42.5 a

3- Grain , straw and biological yield /fed and harvest index:

Data for the residual effect of mineral N fertilizer levels on grain, straw and biological yield /fed as well as harvest index in 1996/97 and 1997/98 seasons, are presented in Table (29) .

3-1- Grain yield (kg /fed) :

Generally, it was observed that insignificant increases were obtained in grain yield /fed as a result of the residual effect of mineral N fertilizer in both seasons . However, all increases were not great enough to reach the 5% level of significance. Such results are expected since growth characters and yield components of wheat showed no response the residual effect of N fertilizer treatments in both seasons. The present results may be mainly due to application of 150 kg N/fed level recorded the highest values (2504.0 kg in the 1st season and 2549.0 kg in the 2nd season) and the check treatment gave the lowest values (2475.0 kg in the 1st season and 2470.0 kg in the 2nd season). However, the differences among the four residual effect treatments were insignificant. Such results are expected since growth characters and yield components of wheat did not response to the residual effect of N levels.

3-2- Straw and biological yield /fed and harvest index :

Results in Table (29) show that straw and biological yield of wheat as well as harvest index were not affected by the residual effect of mineral N fertilizer treatments in both seasons .

The residual effect of 150 Kg N /fed gave the highest values and the unfertilized plot had the lowest values . However, the

Table (29) : The residual effect of mineral N fertilizer on grain , straw and biological yield and harvest index of wheat in 1996/97 and 1997/98 seasons .

Characters N levels (Kg/fed)	Grain yield (Kg/fed)	Straw yield (Kg/fed)	Biologial yield (Kg/fed)	Harvest index (%)
1996 / 1997 season				
0	2475 a	4550 a	7025 a	35.2 a
50	2497 a	4921 a	7418 a	33.7 a
100	2501 a	5277 a	7778 a	32.2 a
150	2504 a	5464 a	7968 a	31.4 a
1997 / 1998 season				
0	2470 a	4261 a	6731 a	36.7 a
50	2477 a	4332 a	6809 a	36.3 a
100	2501 a	4418 a	6919 a	36.1 a
150	2549 a	4557 a	7106 a	35.9 a

difference among the residual mineral N treatments were insignificant . Similar results were also reported by **Arroug , (1985).**

4 - Chemical composition in grain:

Results on chemical content of grain wheat as affected by the residual effect of mineral N fertilizer treatments in 1996/97 and 1997/98 seasons, are shown in Table (30) .

Results showed that N, CP, P and K percentages and their absolute amounts as well as total carbohydrate percentage in grain and absolute amount of carbohydrate were not significantly affected by the residual effect of mineral N fertilizer on wheat in both seasons.

For example, crude protein percentage increased slightly as a results of N residual effect treatments . Application of 150 Kg N/fed gave the highest CP percentage which were 10.2 and 10.37% in the 1st and 2nd seasons , respectively. Whereas, the check treatment gave the lowest CP% which were 10.03 and 10.10 % in the 1st and 2nd seasons ,respectively . Also, the absolute amount of N showed slight increases at all residual treatments in both seasons . The residual effect of 150 Kg N/fed treatment recorded the highest absolute amount of N which were 44.8 and 46.1 Kg/fed in the 1st and the 2nd seasons, respectively .While, the control treatment had the lowest absolute amount of N which were 43.6 and 44.3 Kg/fed in the 1st and 2nd seasons, respectively , but these results were below the level of significance. The same trend were also obtained in P, K and total carbohydrate percentages as well as the total absolute amount of P, K and carbohydrates. However, the differences among all residual effect treatments were not significant. Similar result were also

Table (30) : The residual effect of mineral N fertilizer on chemical composition of wheat in 1996/97 and 1997/98 seasons .

Characters N levels (Kg/fed)	N%	Crude protein (%)	Absolute amount of N (Kg/fed)	P %	Absolute amount of P (Kg/fed)	K %	Absolute amount of K (Kg/fed)	Total carbohydrates (%)	Total carbohydrates yield (Kg/fed)
1996 / 1997 season									
0	1.76 a	10.03 a	43.6 a	0244 a	6.0 a	0428 a	10.6 a	68.1 a	1685 a
50	1.77 a	10.09 a	44.2 a	0248 a	6.2 a	0432 a	10.8 a	69.0 a	1723 a
100	1.78 a	10.15 a	44.5 a	0256 a	6.4 a	0443 a	11.1 a	69.6 a	1741 a
150	1.79 a	10.20 a	44.8 a	0257 a	6.5 a	0452 a	11.3 a	70.7 a	1770 a
1997 / 1998 season									
0	1.77 a	10.10 a	44.3 a	0266 a	6.6 a	0422 a	10.4 a	69.1 a	1707 a
50	1.80 a	10.26 a	44.5 a	0270 a	6.7 a	0433 a	10.7 a	73.8 a	1828 a
100	1.81 a	10.32 a	45.1 a	0271 a	6.8 a	0442 a	11.1 a	74.7 a	1868 a
150	1.82 a	10.37	46.1 a	0270 a	6.9 a	0446 a	11.4 a	75.5 a	1924 a

obtained by **Arroug, (1985)** who found that macro-elements percentages in barley plants showed no significant differences as a result of adding the different mineral N fertilizer. However, it was noticed that all N treatments caused a slight increases in mineral concentrations .

C-The residual effect of Biogas sludge :

Results for the residual effect of Biogas sludge treatments on growth characters, grain yield and yield components as well as chemical composition of wheat grains in 1996/97 and 1997/98 seasons, are shown in Tables (31, 32, 33 and 34).

1- Growth characters:

Vegetative growth characters of wheat, namely, plant height number of tillers /m^2, flag leaf area, number of leaves /stem and dry weight of different plant organs and total dry weight /plant in 0.25 m^2 at 95 days from planting in both seasons were not affected by the residual effect of Biogas sludge are shown in Table (31) . Results indicated that the residual effect of Biogas sludge at both treatments showed no significant effect on all studied growth characters in both seasons of experimentation . It was clear that increases in all growth characters of wheat were obtained as a result of the residual effect of Biogas sludge treatments were below the level of significance. Slight increases in some characters were obtained as a result of the residual effect of Biogas sludge treatment (5m^3 BS/fed).

Table (31) : The residual effect of Biogas sludge on growth characters of wheat at 95 days from planting in 1996/97 and 1997/98 seasons .

Characters Biogas sludge	Plant height (cm)	No. of tillers/ (m^2)	Flag leaf area (c m^2)	No. of leaves / stem	Dry leaves weight/0.25 m^2	Dry stems weight/0.25 m^2 (g)	Total dry weight/ plant (0.25 m^2) (g)
1996 / 1997 season							
0	71.5 a	331.7 a	29.6 a	3.95 a	39.8 a	75.3 a	115.1 a
5 m^3	72.1 a	334 a	30.2 a	4.07 a	40.3 a	75.8 a	116.1 a
1997 / 1998 season							
0	76.3 a	341.1 a	28.9 a	3.85 a	36.8 a	72.4 a	109.2 a
5 m^3	77.4 a	341.4 a	28.9 a	3.99 a	37.3 a	73.1 a	110.4 a

2- Grain yield components :

Results on grain yield components of wheat as affected by the residual effect of Biogas sludge treatments in 1996/97 and 1997/98 seasons are shown in Table (32) . Results showed that number of tillers /m^2, number of spikes /m^2, spike length, spike weight , number of grains /spike and 1000-grain weight were not significantly affected by adding Biogas sludge treatments on maize and it there residual effect on wheat in both seasons of experimentation . However, all growth characters were favorably affected by the residual effect of biogas sludge , where insignificant increases were observed as a result of residual effect of Biogas sludge at both levels used. For example, the number of spikes /m^2 increased slightly as a result of these residual effect treatments . Increases in number of spikes/m^2 over the control treatment were 0.7% in the 1st season and by 0.6% in the 2nd season . The residual effect of Biogas sludge treatment gave the highest numbers (379.6 in the 1st season and 429.7 in the 2nd season) . While, the control treatment gave the lowest ones (377.0 in the 1st season and 427.2 in the 2nd season). Also, number of grains /spike of wheat showed slight increases at both residual effect treatments in both seasons. The residual effect of 5 m^3 BS/fed treatment recorded the highest number of grains /spike (25.1 in the 1st season and 26.3 in the 2nd season). Whereas, the control treatment gave the lowest numbers (24.0 in the 1st season and 25.9 in the 2nd season). This was true in both seasons . The present results may be attributed to the fast decomposition of Biogas sludge in the soil during the summer season. Also, the amount used of Biogas sludge (5m^3 /fed) on maize was not enough to show

Table (32) : The residual effect of Biogas sludge on the yield components of wheat in 1996/97 and 1997/98 seasons .

Characters Biogas sludge	No. of tillers / m^2	No. of spikes/ m^2	Spike length (cm)	Spike weight (g)	No. of grains/ spike	1000- grain weight (g)
1996/1997 Season						
0	391.0 a	377.0 a	6.43 a	1.82 a	24.0 a	31.6 a
5 m^3	392.2 a	379.6 a	6.76 a	1.88 a	25.1 a	31.9 a
1997/1998 Season						
0	431.0 a	427.2 a	8.53 a	2.34 a	25.9 a	42.2 a
5 m^3	432.1 a	429.7 a	8.80 a	2.44 a	26.3 a	42.6 a

positive effect on growth characters and yield components of wheat. The data indicate that the residual effect of FYM (Balady manure) after maize are not sufficient to give high growth or mineral content of barley **(Arroug, 1985)** .

3- Grain , straw and biological yield /fed and harvest index:

Data for the residual effect of Biogas sludge treatments on grain, straw and biological yield as well as harvest index in 1996/97 and 1997/98 seasons, are presented in Table (33) .

3-1- Grain yield (kg /fed) :

Generally, it was observed that insignificant increases were obtained in grain yield /fed as a result of the residual effect of Biogas sludge in both seasons . However, all increases were not great enough to reach the 5% level of significance. Such results are expected since growth characters and yield components of wheat showed no response due to the residual effect of Biogas sludge treatments in both seasons. Application of 5 m^3 Biogas sludge treatment recorded the highest values of grain yield /fed which were (2539.8 kg in the 1st season and 2545.0 kg in the 2nd season) and the check treatment had the lowest values (2448.8 kg in the 1st season and 2453.5 kg in the 2nd season) . However, the differences between the two residual effect treatments were insignificant.

3-2- Straw and biological yield /fed and harvest index :

Results in Table (33) show that straw and biological yield of wheat as well as harvest index were not affected by the residual effect of Biogas sludge treatments in both seasons .

Table (33) : The residual effect of Biogas sludge on grain , straw and biological yields and harvest index of wheat in 1996/97 and 1997/98 seasons .

Characters Biogas sludge	Grain yield (Kg/fed)	Straw yield (Kg/fed)	Biologial yield (Kg/fed)	Harvest index (%)
1996 / 1997 season				
0	2448.8 a	4890.2 a	7339 a	33.4 a
5 m^3	2539.8 a	5216.2 a	7756 a	32.7 a
1997 / 1998 season				
0	2453.5 a	4360.5 a	6814 a	36 a
5 m^3	2545 a	4424.0 a	6969 a	36.9 a

The residual effect of $5m^3$ BS/fed gave the highest values and the unfertilized plot had the lowest values . However, the difference between the residual organic manure treatments were insignificant . The growth period for Biogas immediate effects on maize and the following wheat was too long time for exhausting the reserves in the organic manure . Similar results were also reported by **Arroug , (1985).**

4 - Chemical composition in grain:

Results on chemical content of grain wheat as affected by the residual effect of Biogas sludge treatments in 1996/97 and 1997/98 seasons are shown in Table (34) .

Results showed that N, CP , P ,K percentages and their total amounts as well as total carbohydrate percentage in grain and amount of carbohydrate were not significantly affected by the residual Biogas sludge of wheat in both seasons .

For example, the nitrogen percentage increased slightly as a results of both residual effect treatments . Application of $5m^3$ Biogas sludge/fed gave the highest N percentage (1.78 %in the 1st season and 1.81% in the 2nd season). Whereas, the check treatment gave the lowest N% (1.77% in the 1st season and 1.79% in the 2nd season). Also, the absolute amount of in grain showed slight increases at both residual treatments in both seasons . The residual effect of $5m^3$ BS/fed treatment recorded the highest absolute amount of N which were 45.2 kg

Table (34) : The residual effect of Biogas sludge on chemical composition of wheat in 1996/97 and 1997/98 seasons .

Characters Biogas sludge	N%	Crude protein (%)	Absolute amount of N (Kg/fed)	P %	Absolute amount of P (Kg/fed)	K %	Absolute amount of K (Kg/fed)	Total carbohydrates (%)	Total carbohydrates yield (Kg/fed)
1996 / 1997 season									
0	1.77 a	10.10 a	43.3 a	0.429 a	6.1 a	0.429 a	10.5 a	68.6 a	1679.9 a
5 m^3	1.78 a	10.15 a	45.2 a	0.448 a	6.42 a	0.448 a	11.4 a	70.1 a	1780.4 a
1997 / 1998 season									
0	1.79 a	10.20 a	43.9 a	0.268 a	6.57 a	0.435 a	10.7 a	72.6 a	1781.2 a
5 m^3	1.81 a	10.32 a	46.1 a	0.271 a	6.90 a	0.437 a	11.1 a	73.9 a	1881.0 a

N in the 1st season and 46.1 kg in the 2nd season. While, the control treatment had the lowest absolute amount of N which were 43.3 kg N in the 1st season and 43.9 kg in the 2nd season, but these results were below the level of significance. The same trend were also obtained in P, K and total carbohydrate percentages as well as the total absolute amounts of P, K and total carbohydrates. However, the differences between both the residual effect treatments was not significant. Similar result were also obtained by **Arroug, (1985)** who found that macro-elements percentages in barley plants showed no significant differences as a result of adding the different manurial treatments. However, it was noticed that both Biogas manure treatments caused a slight increases in mineral concentrations .

D- Interaction effects :

1-The residual effect of mineral N fertilizer and Biogas sludge of wheat .

All growth characters of wheat, namely, plant height, number of tillers/m^2 , flag leaf area, number of leaves /stem, dry weight of different plant organs of wheat and total weight /0.25 m^2 were not affected by the interaction between the residual mineral N fertilizer and Biogas sludge treatments in 1996/97 and 1997/98 seasons . Also, yield components, namely, number of tillers/m^2, number of spikes/m^2, spike length, spike weight, number of grains/spike, 1000-grain weight, grain, straw and biological yield and harvest index as well as chemical composition in grains, namely, N, CP, P , K and total carbohydrate percentages in grain and their absolute amounts in

grains in both seasons were not affected by the residual mineral N fertilizer and Biogas sludge treatments on wheat . Consequently, the data were exclude.

2-Effect of the interaction between the residual effect of Biogas sludge and N levels on wheat.

All growth characters ,grain yield components , grain, straw and biological yield/fed, harvest index and chemical composition in grains in both seasons except, K% in grain in the 1st season and total carbohydrate % in grains in the 2nd season were not affected by the residual Biogas sludge and applied N levels on wheat. Consequently, the data were exclude .

2-1-K % in grain :

Results in Table (35) show that K% in grain was significantly affected by the interaction between the residual Biogas sludge effect and applied N levels on wheat in 1996 /97 season. Results showed that at the residual $5m^3$ BS /fed level, significant effect of N application on K% in grains of wheat was detected. The highest K% in grains (0.485%) was obtained at the residual $5m^3$ BS + 90 kg N /fed level. However, the difference between 60 and 90 kg N/fed levels as well as between zero and 30 kg N/fed levels were insignificant.

2-2-Total carbohydrate % in grain :

Results recorded in Table (35) revealed that total carbohydrates percentage in grain was significantly affected by the interaction between the residual Biogas sludge effect and N treatments in 1997

/98 season. The highest total carbohydrates % in grains (79.9%) was obtained at 90 kg N + the residual effect of $5m^3$ BS /fed treatment, whereas the lowest one was obtained by adding zero N+ the residual effect of $5m^3$ BS /fed level.

Table (35): Interaction effect of the residual effect of Biogas sludge and N levels on potassium and total carbohydrates percentages in grains of wheat in 1996/97 and 1997/98 growing seasons.

Characters	Biogas Sludge (m^3/fed.)	N - levels(Kg N/fed.)							
		0	30	60	90	0	30	60	90
		1996/97 season				1997/98 season			
K (%) in grain	0	0.429	0.441	0.417	0.430	0.417	0.414	0.435	0.456
	5	0.412	0.432	0.465	0.485	0.419	0.437	0.440	0.452
	L.S.D (0.05) = 0.044					L.S.D (0.05) = N.S			
Total carbohydrates(%)	0	66.7	68.6	69.2	70.1	73.9	37.7	71.5	71.4
	5	67.7	68.9	71.2	72.5	71.3	71.3	73.2	79.9
	L.S.D (0.05) = N.S					L.S.D (0.05) = 0.309			

3- Effect of the interaction between the residual effect of N and different N levels on wheat :

The interaction between the residual effect of mineral N fertilizer and different N rates did not affect all studied characters in this experiment except total carbohydrate percentage in grain. Consequently, the data were excluded .

3-1- Total carbohydrate % in grain :

Data in Table (36) indicated that the residual mineral N fertilizer and different N levels significantly affected on total carbohydrate % in grain of wheat in 1997/98 season . Total carbohydrate % reached its highest values (79.8%) by the residual mineral N fertilizer and N level

(150 kg N + zero N/fed), whereas, the lowest value (65.4%) was recorded by the residual N zero + 60 kg N/fed treatment .

Table (36): Interaction of the residual mineral N fertilizer effect and N levels on total carbohydrates percentage in grain of wheat in 1996/97 and 1997/98 seasons.

Characters	Biogas Sludge (m^3/fed.)	N - levels(Kg N/fed.)							
		0	30	60	90	0	30	60	90
		1996/97 season				1997/98 season			
Total carbohydrates(%)	0	67.4	66.4	69.8	69.2	67.0	68.7	65.4	75.5
	50	66.5	67.9	69.7	71.8	74.5	73.1	77.5	70.9
	100	67.7	70.3	70.7	69.7	68.2	71.6	75.1	79.0
	150	67.4	70.4	71.0	74.0	79.8	76.8	72.5	77.2
	L.S.D (0.05) = N.S.					L.S.D (0.05) = 5.6			

4- Effect of the interaction between the residuals effect (N x BS) and different N levels on wheat :

All studied characters of wheat were not affected by the interaction between the residual effects and N levels on wheat in both seasons .