Response of Maize to N Fertilization Following Sunflower and Preceding Winter Crops

Hassan E. Khalil[1]; Ali I. Nawar[2]; Abdel Aziz M. Abou-Elela[1]; Ismail E. Mohammadein[1] and Mansour E. El-Sodany[3]

[1] Crop Intensification Dept., Field Crops Inst., A.R.C., Giza, Egypt.
[2] Crop Science Dept., Faculty of Agriculture, Alexandria University, Egypt.
[3] Soil, Water and Environment Research Inst., A. R. C., Giza , Egypt.

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ABSTRACT

A two summer seasons investigation, 2006/2007 and 2007/2008, was conducted to study the effect of sugar beet, wheat and faba bean (as preceding winter crops) on sunflower, as a first summer crop and on maize, which was supplied with 90 (=N1), 105 (=N2), 120 (=N_3) and 135 kg N/fed (=N4), as a second summer crop.

Head seed weight, 100-seed weight and seed yield/fed of sunflower were significantly influenced by the preceding winter crops, where these traits had the maximum values following faba bean. Responses of seed yield/fed were 981.67, 861.90 and 832.30 kg, in 2006/2007, and 990.70, 871.10 and 832.60 kg in 2007/2008, after faba bean, wheat and sugar beet, respectively.

Preceding winter crops significantly affected all studied maize traits, except for ear height, number of leaves/plant and ear leaf area during the two seasons of study. Maize grain yield/fed was superior after faba bean by an average of 1.99 and 2.19 ardabs/fed to maize following wheat and sugar beet, respectively.

All the studied characters of maize, except for ear height and number of leaves/plant, showed significant response to N levels. The N4, which was statistically equal to N3 level, significantly exceeded the N1 and N2 levels for ear grain weight, 100-grain weight and grain yield/fed during the two seasons. Maize supplied with 135 kg N/fed produced grain yields that were higher by 0.17, 1.27 and 1.56 ardabs/fed, in the first season, and 0.23, 1.18 and 1.83 ardabs/fed in the second season, compared to 120, 105 and 90 kg N/fed application, respectively.

Stepwise regression analysis, in both seasons, revealed that both grain number/ear and 100-grain weight explained 93 and 99% of the variations in maize grain yield in the first and second seasons, respectively, overall N levels and preceding crops, indicating the importance of such grain yield components in determining maize grain yield/fed. That was further elucidated through the significant correlation coefficients between grain yield and both grain number/ear (0.90^{**} and 0.92^{**}) and 100-grain weight (0.81^{*} and 0.92^{**}) in the two seasons, respectively.

Key words: Maize, Sunflower, nitrogen fertilization, preceding winter crops, yield and yield components

INTRODUCTION

Suitable land area for food production remains fixed or decreasing, yet agronomists are faced with the task of increasing crop productivity. Yield advantage of land could be achieved through a more effective use of natural and supplied resources over the year. Crop intensification through time dimension represents a major procedure for increasing land use that provides the choice of appropriate combination of crop sequences and a crop positioning within each sequence. Intensive crop sequence (more than two crops grown in sequence) needs saving time enough for a third (triple) and fourth (quadruple) crop growing. Saving time to establish these patterns could be achieved by modification in agricultural practices, through relay cropping and/or growing of early maturing varieties. Relay cropping of maize, with early maturing sunflower cultivars, will save time through elimination of turn over period between two successive crops. Responses of a crop to its position in crop sequence were reported in several studies. Gouda (1989) showed that gradual decay of residues, left after clover, established a continuous supply of nitrogen to the following growing crop. Khalil *et al* (2003a, b) supported these results and revealed that sunflower yield and its attributes (100-and head seed weights) tended to be higher following legumes than after non-legumes. Several investigators examined the effect of different preceding crops on maize traits, including plant height (Selim and El-Sergany, 1995 and Sparrow *et al.*, 1995), number of leaves/plant and leaf area (Khalil *et al.*, 1999 and 2000), number of grains/ear, ear grain weight and grain yield per faddan (Nawar, 2004) and reported positive effects of legume crops on studied traits.

Nitrogen plays a vital role in plant growth, concerning the development of vegetative and reproductive organs (Gardner *et al.*, 1985). Several studies were conducted to investigate the effect of N supply on growth aspects of maize. Amer *et al.* (1995 and Nawar (2004) reported that N supply to maize increased plant height, number of leaves/plant and leaf expansion. However, Connor *et al.* (1993), McCullough (1994), Uhart and Andrade (1995) and Nawar (2004) attributed the increases in maize grain yield to the increase in number of grains/ear and single grain weight as affected by increasing N levels.

This investigation was carried out to determine the beneficial effect of relay cropping as a time saving factor for multiple cropping. It, also, aimed to examine the effect of different winter crops on sunflower, as a first summer crop, and the response of maize, as a second summer crop, to nitrogen fertilization rates following these crops.

MATERIALS AND METHODS

A two-year study was conducted during 2006/2007 and 2007/2008 summer seasons at El-Gemmiza Agricultural Research Station, Agricultural Research Center, Egypt. This investigation was laid out to study the effect of three preceding winter crops on sunflower, as a first summer crop, and on maize, as a second summer crop, supplied with four N levels. The preceding winter crops were sugar beet (Beta Poly cv.), wheat (Gemmiza 7 cv.) and faba bean (Giza 716 cv.). These crops were sown in a randomized complete block design, with three replicates. Sunflower (Sakha 51 cv.) was sown following the three winter crops as a relay crop, in plots of 23 ridges for each. Sunflower plots were divided into four sub-plots, in which maize (Giza 310 cv.) was sown, as a relay crop to sunflower, and was fertilized with four N rates; i.e., 90, 105, 120 and 135 kg N/fed. Thus, the analysis of maize data was carried out as a split-plot design, where the preceding winter crops comprised the main plots and the N fertilization rates occupied the sub-plots. Each sub-plot was 12.6 m^2 in area, consisting of seven ridges (each, three m long and 0.6 m wide).

Sugar beet was sown on one side of ridges in hills (one plant/hill) at a distance of 20 cm between hills. Faba bean was sown on the upper and one side of ridges in hills (2 plants/hill), spaced at 20 cm apart. Meanwhile, wheat was drilled in two rows, on the upper and one side of ridges.

Sowing dates were November 15thfor faba bean and wheat, and October 10th for sugar beet in the first season, with a delay in sowing of five days for these crops in the second season.

Relay cropping of sunflower into the preceding winter crops was carried out on March 20th and 25th, while, relay cropping of maize into sunflower stand was on June5th and 10th, in the two successive seasons, respectively.

Nitrogen, as ammonium nitrate (33.5% N) was added to maize in two equal splits, at the first and second irrigations. Sunflower was relay cropped into the preceding winter crops on the side of ridges in hills (one plant/hill), spaced at 20 cm apart. Maize, also, was relay cropped into sunflower stand, after harvesting winter crops, on the other side of ridges in hills (one plant /hill) at 30 cm among plants. All other cultural practices were uniformly applied according to recommendations.

At sunflower and maize harvesting, the plants of inner five ridges were taken from each experimental unit. Characters recorded for sunflower were plant height (cm), number of leaves/plant, head diameter (cm), head seed weight (g), 100-seed weight (g) and seed yield/fed. (kg). Measured traits of maize were plant height (cm), ear height (cm), number of leaves/plant, ear leaf area (cm^2), number of grains/ear, ear grain weight (g), 100-grain weight (g) and grain yield/fed. (ardab).

Analysis of data was conducted, according to Gomez and Gomez (1984). Comparison of means and computation of simple correlation coefficients between pairs of studied characters were performed.

RESULTS AND DISCUSSION

I. The effect of the preceding winter crops on sunflower:

The analysis of variance presented in Table (1) indicated that preceding crops significantly affected plant height in the second season, in addition to head seed weight, 100-seed weight and seed yield /feddan in both seasons.

Data in Table (2) showed that plant height of sunflower plants increased, insignificantly (in 2006/2007) and significantly (in 2007/2008) following faba bean in comparison with sunflower grown after wheat and sugar beet, which might be due to the enhancement of sunflower growth attributed to the soil higher content of organic matter and nitrogen (Khalil *et al.*, 1999 and 2000). The longer growth duration of sugar beet, which was associated with a decline in soil N and organic matter supply, might be responsible for its shortest plants stature (El-Sodany and Abou-Elela, 2010).

Variations in head seed weight of sunflower plants, as affected by the preceding winter crops, were significant in both seasons, where they ranked first, second and third after faba bean, wheat and sugar beet, respectively. The heaviest seed weight of sunflower heads, after faba bean, might be due to the beneficial effect of faba bean residues (higher organic matter soil content and N supply) on subsequent sunflower, in terms of increases in photosynthesis and photoassimilates flux into sunflower heads to increase the head seed weight (Gardner *et al*, 1985 and Loomis and Connor, 1992). However, the lower response of sunflower to sugar beet effect might be explained by the lower amounts of residual organic matter and N that decreased the rate of photosynthetic processes and, hence, the amount of dry matter accumulated into seeds, thus, lowering head seed weight of sunflower plants (Khalil *et al*, 2003a).

One-hundred seed weight of sunflower after faba bean was significantly superior to that after wheat and sugar beet in both seasons. That could be attributed to the more availability of N after faba bean, which led to the greater N uptake by sunflower plants, compared to plants after wheat and sugar beet. The more the N uptake, the greater the photoassimilation production and translocation to head seed, resulting in an increase of seed weight.

It should be noted that significant variations were found among the preceding crops for seed yield in both seasons. Sunflower after faba bean produced 119.77 and 149.37 kg, in the first season, and 119.60 and 158.10 kg in the second season, greater than seed yields after wheat and sugar beet, respectively.

Improving soil physical structure and high content of N and organic matter, after faba bean, were favorably reflected in higher productivity of the subsequent sunflower seed yield and its components. It might be concluded that faba bean, as a preceding crop, was superior to wheat and sugar beet in this respect. This might be attributed to the good residual effect of the legume and enriching the soil with N and organic matter (Summerfield and Roberts, 1985; Echeverria *et al.*, 1992 and Khalil *et al*, 1999 and 2000), in addition to decreasing the solubility of Mg, Na, HCO_3 and sodium adsorption ratio (SAR) while increasing the solubility of K and total N, P and K available in the soil (El-Sodany and Abou-Elela, 2010). Furthermore, head diameter and number of leaves/plant of sunflower were insignificantly increased after the three preceding crops in both seasons (Table 2).

II. Maize response to N levels following different preceding crops:

Data of analysis of variance (Table 3) indicated that plant height, number of grains/ear, ear grain weight, 100-grain weight and grain yield per feddan significantly responded to the effect of the preceding winter crops during the two seasons. Meanwhile, variations among N rates were significant for plant height, ear leaf area, number and weight of grains/ear, 100-grain weight and grain yield per feddan in both seasons. Furthermore, analysis failed to detect any interaction between the preceding crops and N rates, indicating that the two factors independently affected maize growth and yield traits.

The mean values of the studied traits are presented in Table (4). Data indicated that maize after faba bean produced taller plants, compared to plants after the two other preceding winter crops. The increase in plant height for S_3 plants, compared to that of S_2 and S_1 plants, might be attributed to the higher soil organic matter and N content that largely enhanced the maize vegetative growth in terms of plant height (Khalil *et al.* 1999 and 2000) and better physical and chemical soil properties (El-Sodany and Abou-Elela, 2010). Ear grain number was found to be significantly greater after faba bean than following either wheat or sugar beet. Increases in number of grains/ear for maize after faba bean were 20.0 and 26.83, in the first season, and 22.25 and 27.17 grains in the second season, compared to maize after sugar beet and wheat, respectively. Increasing soil organic N and carrying over of N from faba bean residues to the subsequent maize might be responsible for such increase in grain number/ear. Physiologically, the greater N uptake of maize plants after faba bean increased maize photosynthetic rate and photoassimilates translocation to ear, resulting in success of fertilization of flower ovules and, hence, increasing grain setting, which caused the number of grains/ear to be higher for maize ear after faba bean than did after the other preceding crops. Maize lower N uptake, following sugar beet and wheat, due to greater N uptake by sugar beet and N immobilization by wheat residues for a longer period (Rizvi and Rizvi, 1992), decreased photoassimilates productivity and translocation into ears, ovules fertilization and, finally, the number of grains/ear.

Data on the effect of the preceding crop on weight of grains/ear revealed that such trait exhibited significant responses as influenced by the preceding winter crops (Table 4). Variations in weight of grains/ear were significant among the preceding crops, where the maximum and minimum records of such trait were obtained from maize grown following faba bean (S_1) and sugar beet (S_3), respectively. The two-season average of ear-grains weight of maize following faba bean was 115.0 g, which was higher by 10.03 and 13.85 g over that obtained from maize following wheat and sugar beet, respectively. Improvement of physical and chemical properties, regarding the soil N and organic matter content, might be associated with greater N uptake, followed by enhanced photoassimilates translocation into ear-grains, which produced the heaviest weight of grains/ear after faba bean, compared to that after the other preceding crops.

It should be noted that maize, grown after faba bean significantly exceeded maize following wheat and sugar beet in 100-grain weight (Table 4). On the average of the two seasons, maize plants after faba bean produced the heaviest 100-grain weight, which was 1.05 and 1.72 g greater than that of maize after wheat and sugar beet, respectively. Reduction in N uptake after wheat and sugar beet, compared to faba bean, declined the amount of photoassimilates translocated to ear grains, resulting in a decrease in single grain weight.

Table 1: Mean squares of the studied characters in sunflower during 2006/2007 and 2007/2008 seasons.

S.O.V.	d.f.	Plant height		Number of leaves/ plant		Head diameter		Head seed weight		100-seed weight		Seed yield / fed.	
		2006/07	2007/08	2006/07	2007/08	2006/07	2007/08	2006/07	2007/08	2006/07	2007/08	2006/07	2007/08
Treatments	2	n.s.	*	n.s.	n.s.	n.s.	n.s.	*	*	*	*	*	*
Error	4	10.15	8.9	4.5	4.8	0.41	0.14	9.5	11.0	0.12	0.16	78.40	64.90

n.s.: Not significant.
* Significant at 0.05 level of probability.

Table 2: Means of studied characters in sunflower during 2006/2007 and 2007/2008 seasons.

Treatments (preceding crops)	Plant height (cm)		Number of leaves/ plant		Head diameter (cm)		Head seed weight (g)		100-seed weight (g)		Seed yield (Kg/fed).	
	2006/07	2007/08	2006/07	2007/08	2006/07	2007/08	2006/07	2007/08	2006/07	2007/08	2006/07	2007/08
Sugar beet (Su)	139.44	132.61	20.80	21.40	15.84	15.85	48.33	48.70	6.69	6.82	832.30	832.6
Wheat (Wh)	140.60	134.98	21.40	21.80	16.20	16.04	58.30	59.00	6.90	7.80	861.90	871.1
Faba bean (Fb)	144.43	137.89	21.90	22.10	16.79	16.62	60.10	59.83	7.81	8.10	981.67	990.7
$L.S.D._{0.05}$	n.s.	6.76	n.s.	n.s.	n.s.	n.s.	6.69	7.52	0.79	0.91	20.07	18.26

n.s.: Not significant

Furthermore, data in Table (4) revealed that faba bean was the highest, as a preceding crop to maize, in its effect on maize grain yield. Maize after faba bean produced 1.34 and 2.11 ardabs, in the first season, and 1.63 and 2.25 ardabs, in the second season, greater than yields of maize after wheat and sugar beet, respectively. Soil physical conditions and soil content from available N and organic matter after faba bean were favorably improved, leading to the higher productivity of grain yield components for maize grown after faba bean, compared to being grown following the other preceding crops.

In conclusion, faba bean was superior to both wheat and sugar beet regarding all the studied characters of maize. That was in an agreement with the results of Khalil *et al.* (1999 and 2000), Khalil *et al* (2003 b) and Nawar (2004) who reported, in different studies, that leguminous crops caused maize to produce higher values of grain yield attributes, such as number of grains/ear, ear-grain weight and single grain weight, in addition to grain yield per feddan. In addition, Lemcoff and Loomis (1988) and Holland and Herridge (1992) concluded that less N uptake by legume plants increased the uptake of N by the following non-legumes, enhancing photosynthesis to increase photoassimilates translocation to plant different sinks and, in turn, enhancing yield and yield components.

Data regarding the mean values of maize growth traits, as affected by nitrogen application, are presented in Table (4). Mean values, regarding plant height, showed that such trait significantly responded to N supply. It was clear that plant height proportionally increased to the increase in the rate of N supplied during the two seasons. Maize plants supplied with 135 kg N/fed. were 25.0, 14.45 and 5.12 cm (in 2006/2007) and 22.34, 12.67 and 5.0 cm (in 2007/2008) taller than those receiving 90, 105 and 120 kg N/fed, respectively. These results might be attributed to the stimulating effect of N on the internode elongation during the vegetative growth period in maize. These results were in agreement with those of Amer *et al.* (1995) and Nawar (2004) who reported that increasing N application resulted in a proportional increase in plant height of maize plants.

Data in Table (4), further, showed that variations in ear leaf area were significantly affected by applied N rates. The trend was well defined, where it showed a proportional increase in leaf area with increase in N rate. Despite of the similarity between N_4 and N_3 in the leaf area of topmost ear, the N_3 rate significantly exceeded the N_2 and N_1 in such trait. The increase in N supply and greater N uptake by maize might have increased the leaf length and width dimensions, leading to increases in ear leaf overall area (Gardener *et al.*, 1985). These results contradicted those of McCullough *et al.* (1994), but, were in agreement with those of Uhart and Andrade (1995) who reported that single leaf expansion proportionally increased to the increase in applied N.

The effect of different N rates, which were applied to maize, on maize traits of number of grains and weight of grains/ear were significant. The two traits followed the same trend of change during the two seasons (Table 4). The values of grain number and grain weight/ear were increased in a direct proportion with the increase in N rate. Increases in N rate from N_1 to N_2, N_3 and N_4 increased grain number/ear by 8.44, 15.66 and 18.12 grains, in the first season, corresponding to 12.76, 20.47 and 22.22 grains in the second season, respectively. On the other hand, increases in ear grain weight for N_4 rate were 3.6, 6.16 and 9.87 g, in the first season, and were 4.0, 8.71 and 9.65 g greater in the second season, compared to N_3, N_2 and N_1 nitrogen rates, respectively. Mc Cullough *et al.* (1999) and Uharte and Andrade (1995) pointed out that leaf area index, leaf area duration and crop photosynthetic rate, as well as light uptake and use efficiency, increased with increasing N application rate, hence, photoassimilates production and translocation to ear increased, leading to increase of grain setting. Similarly, Connor *et al.* (1993) attributed the increase in ear weight of maize plant to increases in grain number and photoassimilates translocation into ears as N rate increased.

One-hundred grain weight and grain yield showed similar trends in their response to N supply over the two seasons. Both characters proportionally increased with the increase of applied N rate. The percentage increase in 100-grain weight, compared to N_1, as an average of the two seasons, were 2.4, 5.96 and 6.74 for N_2, N_3 and N_4, respectively. The grain yield was directly related to the rate of N applied, where the higher application of N resulted in higher increases in grain yield. Grain yield in N_3, which was statistically equal to that of N_4, was 1.15 and 1.39 ardabs higher, in the first season, compared to that obtained when applying 105 and 90 kg N/fed, respectively.

It could be concluded that lack of N seriously affected the grain yield because it reduced ear grain weight and its attributes; i.e., ear grain number and grain weight. Losses in grain number might be a result of failure in spikelets fertilization and/or increases in the abortion of developed grains due to inadequate N supply. A reduction in N supply, paralleled with a decrease in N crop growth rate, caused a drop in current assimilates efflux to the spikelets, leading to spikelets competition for assimilates and fertilization failure with a reduction in grain number, grain weight and, finally, grain yield. This conclusion has been presented by several investigators, such as Uhart and Andrade, (1995), Hassan (1995) and Nawar (2004). These results were

Table 3: Mean squares of the studied characters in maize during 2006/2007 and 2007/2008 seasons.

S.O.V.	d.f.	Plant height	Ear height	Number of leaves/ plant	Ear leaf area	No. of grains/ ear	Ear grain weight	100-grain weight	Grain yield /fed.
					2006/2007				
Crop sequence (A)	2	*	n.s.	n.s.	n.s.	*	*	*	*
Error (a)	4	27.928	4.99	1.66	44.12	37.74	11.68	0.630	0.210
Nitrogen level (B)	3	*	n.s.	n.s.	*	*	*	*	*
A x B	6	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Error (b)	18	24.75	2.11	0.98	75.42	33.71	1.74	0.530	0.052
					2007/2008				
Crop sequence (A)	2	*	n.s.	n.s.	n.s.	*	*	*	*
Error (a)	4	119.38	4.20	2.04	11.08	44.20	26.78	1.036	0.096
Nitrogen level (B)	3	*	n.s.	n.s.	*	*	*	*	*
A x B	6	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Error (b)	18	74.00	3.84	1.37	143.93	52.87	16.38	0.146	0.133

n.s.: Not significant * Significant at 0.05 level of probability

Table 4: Means of studied characters in maize during 2006/2007 and 2007/2008 seasons.

Treatments	Plant height (cm)		Ear height (cm)		Number of leaves/ plant		Ear leaf area (cm^2)		No. of grains/ ear		Ear grain weight (g)		100-grain weight (g)		Grain yield /fed. (ardab)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Crop sequence:																
Su- Sun-M (S_1)	297.92	305.75	141.83	145.62	16..25	16.50	744.17	755.00	305.92	297.25	104.14	98.17	32.67	33.30	14.88	14.43
W- Sun-M (S_2)	308.75	308.5	142.08	145.62	16.25	16.67	745.50	756.08	312.75	302.17	107.43	102.51	33.36	33.96	15.65	15.05
Fa-Sun-M (S_3)	321.58	326.75	142.92	145.90	16.33	16.67	748.83	756.92	332.75	324.42	116.07	113.93	34.47	34.94	16.99	16.68
L.S.D.$_{0.05}$	5.99	12.39	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	6.92	6.53	11.66	5.86	0.90	1.15	0.52	0.35
N level (kg N/fed):																
90 = N_1	295.56	301.33	142.22	145.00	16.22	16.50	544.75	551.08	306.56	394.33	104.15	99.28	32.21	32.89	15.04	14.39
105 = N_2	306.11	311.00	141.89	145.44	16.28	16.50	563.67	565.42	315.00	306.09	107.86	103.28	33.05	33.64	15.23	15.04
120 = N_3	315.44	318.67	142.33	145.54	16.28	16.70	567.17	573.08	322.22	314.80	111.62	107.99	34.24	34.74	16.43	15.99
135 = N_4	320.56	323.67	142.67	145.76	16.33	16.70	572.92	578.42	324.78	316.56	114.02	108.93	34.50	34.99	16.60	16.22
L.S.D.0.05	4.93	8.52	n.s.	n.s.	n.s.	n.s.	8.60	11.82	5.75	7.20	3.31	4.01	0.72	0.38	0.23	0.33

Su= Sugar beet. W= Wheat. Fa= Faba bean. Sun= Sunflower. M= Maize. n.s. : Not significant.

Table 5: Simple correlation coefficients between pairs of studied characters in 2006/2007 and 2007/2008 seasons.

Characters		X2	X3	X4	X5	X6	X7	Grain yield/fed.
100-grain weight (X1)	2006/2007	0.97**	0.93**	0.07	.93**	0.85*	0.97**	0.81*
	2006/2008	0.99**	0.92**	0.01	0.86*	0.77	0.96**	0.92**
Ear grain weight (X2)	2006/2007		0.99**	0.06	0.95**	0.88**	0.97**	0.85*
	2006/2008		0.98**	-0.02	0.69	0.66	0.94**	0.99**
Grain number/ear (X3)	2006/2007			0.06	0.94**	0.86*	0.96**	0.90**
	2006/2008			-0.02	0.74	0.73	0.97**	0.98**
Ear leaf area (X4)	2006/2007				0.06	0.03	0.07	0.23
	2006/2008				-0.02	0.05	-0.02	0.31
No. of leaves (X5)	2006/2007					0.74	0.92**	0.71
	2006/2008					0.63	0.76	0.71
Ear height (X6)	2006/2007						0.80*	0.72
	2006/2008						0.78	0.72
Plant height (X7)	2006/2007							0.71
	2007/2008							0.77

*, ** Significant at 0.05 and 0.01 probability levels, respectively.

in accordance with those of Connor *et al.* (1993), Ali *et al.*, (1995) and Nawar (2004). In addition, El-Sodany and Abou-Elela (2010) reported that growing of maize following faba bean and application of 90 kg N/fed gave the highest grain yield per feddan and increased water use efficiency (WUE) compared to growing maize following wheat or sugar beet and application of 90 or 120 kg N/feddan.

Stepwise regression analysis, in both seasons revealed that both grain number per ear and 100-grain weight accounted for 93 and 99% of the variations in maize grain yield in the first and second seasons, respectively, overall N levels and preceding crops. That clearly emphasized the importance of those two traits in determining grain yield and that factors influencing those two traits, such as N application, might eventually affect grain yield. Such finding, also, was confirmed by the simple correlation coefficients between pairs of studied characters (Table 5). Both grain number/ear and 100-grain weight were of significant, or highly significant, and positive relationships with grain yield, in both seasons. Correlation coefficients reached 0.90^{**} and 0.98^{**}, and 0.81^{*} and 0.92^{**}, for grain number/ear and100-grain weight in 2006/2007 and 2007/2008, respectively.

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الملخص العربى

استجابة الذرة الشامية للتسميد النيتروجيني عقب عباد الشمس والمحاصيل الشتوية السابقة

حسن السيد خليل[1]، على عيسى نوار[2]، عبد العزيز محمود أبو العلا[1]، اسماعيل عويس محمدين[1] ومنصور الدسوقى السودانى[3]
[1] قسم بحوث التكثيف المحصولي، معهد المحاصيل الحقلية – مركز البحوث الزراعية - مصر.
[2] قسم المحاصيل، كلية الزراعة (الشاطبي) – جامعة الإسكندرية.
[3] معهد بحوث الاراضى والمياه والبيئة – مركز البحوث الزراعية– الجيزة– مصر.

أجريت تجربتان حقليتان خلال موسمى صيف ٢٠٠٦/٢٠٠٧ و ٢٠٠٧/٢٠٠٨ لدراسة تأثير المحاصيل الشتوية "بنجر السكر والقمح والفول البلدى" على نمو ومحصول عباد الشمس كمحصول سابق للذرة الشامية الذى اضيف اليه اربعة مستويات من التسميد النيتروجينى (N_1 = ٩٠، N_2 = ١٠٥، N_3 = ١٢٠ و N_4 = ١٣٥كجم N/فدان)٠

تأثرت معنويا صفات وزن البذرة/نورة ووزن المائة بذرة ومحصول البذور/فدان فى محصول عباد الشمس بالمحصول الشتوى السابق حيث أعطت أعلى قيم بعد الفول البلدى ، وبلغ محصول البذور/فدان ٩٨١,٦٧ و٨٦١,٩ و٨٣٢,٣ كجم فى (٢٠٠٦/٢٠٠٧) ، ٩٩٠,٧ ، ٨٧١,٩ و ٨٣٢,٦ كجم فى ٢٠٠٧ فى ٢٠٠٧/٢٠٠٨ بعد الفول البلدى والقمح وبنجر السكر على التوالى٠

كان هناك تأثير معنوى للمحاصيل الشتوية السابقة على كل الصفات المدروسة للذرة الشامية ، فيما عدا ارتفاع الكوز وعدد الاوراق للنبات ومساحة ورقة الكوز خلال موسمى الدراسة٠ وكان محصول الحبوب/فدان أعلى معنويا بعد الفول البلدى بحوالى ١,٩٩و ٢,١٩ أردب ، كمتوسط لموسمى الدراسة ،مقارنة بالمحصول بعد القمح وبنجر السكر على التوالى٠

من ناحية أخرى ، اظهرت الصفات المدروسة للذرة الشامية استجابة معنوية لمستويات التسميد النيتروجينى المضاف ، فيما عدا صفتى ارتفاع الكوز وعدد الاوراق/نبات٠فقد تفوق المستوى "N_4" والذى تساوى احصائيا مع المستوى "N_3" ، معنويا على المستويين "N_1, N_2" بالنسبة لصفات وزن الحبوب/كوز ووزن المائة حبة ومحصول الحبوب/فدان فى موسمى الدراسة ،حيث زاد المحصول الناتج من اضافة ١٣٥كجم N/فدان بحوالى٠,١٧ و ١,٢٧ و ١,٥٦ أردب ، (فى الموسم الاول) و ٠,٢٣ و ١,١٨ و ١,٨٣ أردب ، فى الموسم الثانى ، مقارنة باضافة ١٢٠، ١٠٥ ، ٩٠ كجم N/ فدان ، على التوالى٠

أظهر تحليل الارتداد المتدرج ، فى كلا الموسمين، أن كلا صفتى عدد الحبوب/كوز ووزن المائة حبة فسرتا ٩٣ و٩٩% من الاختلافات فى محصول الحبوب للذرة الشامية فى الموسم الأول والثانى ، على التوالى ، كمتوسط لجميع مستويات التسميد الازوتى المضافة والمحاصيل الشتوية السابقة ، مما يشير إلى أهمية مكونى المحصول هذين فى تحديد محصول الحبوب/فدان فى الذرة الشامية٠ والعلاقة القوية بين محصول الحبوب وكلا من عدد الحبوب/كوز ووزن المائة حبة تم تأكيدها من خلال معاملات الارتباط المعنوية بين هاتين الصفتين ومحصول الحبوب والتى بلغت ٠,٩** و ٠,٩٨** لصفة عدد الحبوب/كوز و ٠,٨١* و ٠,٩٢* لصفة وزن المائة حبة فى موسمى الدراسة على التوالى٠