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RESPONSE OF FOUR SUNFLOWER HYBRIDS TO LOW NITROGEN FETILIZER LEVELS AND PHOSPHORINE BIOFERTILIZER

By

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ABSTRACT

Two field experiments were carried out during the two successive growing summer seasons 1998 and 1999 at the Experimental Farm, Faculty of Agriculture, Tanta University, at Kafr El-Sheikh, Egypt. Experiments were designed to study the response of four promising sunflower hybrids i.e. (Vidoc, Alamo, Euroflour and Malabar) to low nitrogen fertilizer levels i.e. (15, 30 and 45 kg N/fed.) and two treatments of phosphorine (without phosphorine as control and with phosphorine). A split-split plot design with four replicates was used in this study. The important findings could be summarized as follows:

1- Sunflower hybrids differed significantly in their growth, yield and its attributing characteristics. Malabar hybrid surpassed the other three hybrids in dry matter accumulation/plant, LAI, CGR, NAR as well as yield and its components.

2- Increasing N- level up to 45 kg N/fed. significantly increased all traits under study, except seed oil content. Increasing nitrogen level tended to decrease seed oil content, however the differences did not reach the level of significant in the first season.

3- Application of phosphorine biofertilizer significantly increased dry matter accumulation/plant in some growth stages, head diameter, number of seeds/head, seed oil content, seed yield/plant as well as seed and oil yields/fed. On the other hand, application of phosphorine did not show any significant effect on LAI, CGR, NAR, days to flowering, plant height at harvest, 100-seed weight and seed husk percent.

4- Generally, the results indicated that Malabar hybrid with 45 kg N/fed. and application of phosphorine biofertilizer could be recommended for optimum sunflower seed yield per unit area under the environmental conditions of this study.

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is one of the most important oil crops in the world. In Egypt, due to the severe shortage of edible oil, sunflower received a great attention. At present, Egypt imports about 4/5 of its annual requirements of edible vegetable oils.

A possible remedy to the present gap between the domestic production and demand for edible oil could be the use of new sunflower genotypes, which cane be imported from different countries of the world. After being grown under local climatic conditions, these genotypes should be evaluated for further introduction (Keshta *et al.*, 1993; El-Hity *et al.*, 1994 a & b; Abou-Ghazala *et al.*, 1996; Salama, 1996; Mohamed, 1997; El-Essawy and Mohamed, 1998; El-Kalla *et al.*, 1998; Abou-Khadra *et al.*, 2000; Basha, 2000 and Abou-Ghazala *et al.*, 2001).

Nitrogen plays an important role in plant growth and is considered the most important fertilizer elements needed for maximum yield in most field crops as well as sunflower, and it should be applied at the optimum rate to meet the crop need (Kassem and El-Mesilhy, 1992 a & b; El-Yamany *et al.*, 1993; El-Hity *et al.*, 1994 a & b; Ibrahim and Helmy, 1995; Abou-Ghazala *et al.*, 1996; Allam and Galal, 1996; Mohamed, 1997; El-Essawy and Mohamed, 1998; El-Kalla *et al.*, 1998; Abou-Khadra *et al.*, 2000; Basha, 2000 and Abou-Ghazala *et al.*, 2001).

Phosphorine as biofertilizer is a commercial compound containing active phosphate dissolving bacteria, have ability to converse the insoluble tricalcium phosphate to the soluble mono-calcium phosphate, supplying the plant with its needs during different growth stages. Radwan (1997); Sherif *et al.* (1997); Hanna (1999) and Hamissa *et al.* (2000) reported that in general, inoculation with phosphate dissolving bacteria increased DM accumulation/plant, yield and its components of different field crops. Radwan (1996) observed that sunflower growth attributes, number and weight of seeds/head, head diameter and seed index were increased significantly by inoculation with phosphate dissolving bacteria compared with non-inoculated plants.

The present investigation was conducted to study the yield potential and oil content of four sunflower hybrids under low nitrogen levels and phosphorine as biofertilizer under the environmental conditions of Kafr El-Sheikh Governorate.

MATERIALS AND METHODS

The present investigation was carried out at the Experimental Farm. Faculty of Agriculture, Tanta University, at Kafr El-Sheikh, Egypt, during the two successive growing seasons 1998 and 1999. The soil of the experimental plots was clay in texture with pH of 8.15, 1.45% organic matter and containing 16.7, 8.65and 283 ppm available N, P and K, respectively (averages of the two seasons for the upper 30 cm of the soil surface). The experiment was laid out in split-split plot design with four replicates. The main plots were assigned to sunflower hybrids (Vidoc, Alamo, Euroflour and Malabar), while sub-plots were allocated to nitrogen levels (15, 30 and 45 kg N/fed.). The two biofertilizer treatments (without phosphorine as control and with phosphorine) were randomly distributed in sub sub-plots.

Each sub-sub plot consisted of 6 ridges each 4 m long and 60 cm in width with 20 cm between hills. Sowing of seeds took place during June 19^{th} and June 22^{nd} in the first and second seasons, respectively. The preceding crop was wheat in the two seasons. Calcium superphosphate (15.5% P_2O_5) was added during seedbed preparation at the rate of 100 kg/fed. Nitrogen fertilizer in the form of Urea (46 % N) was applied at the above mentioned levels in two equal doses. The first was applied after thinning and before the first irrigation and the second was added before the second irrigation. Phosphorine is a commercial biofertilizer containing active phosphate dissolving bacteria, produced by the General Organization for Agricultural Equalization Fund, Ministry of Agriculture. The wetted sunflower seed was thouroughly mixed with phosphorine just before planting, then irrigated soon. Other cultural practices for growing sunflower were conducted as recommended.

Growth analysis was determined on five guarded plants, which randomly taken from each experimental plot. Three samples in both seasons were taken at 52, 62 and 72 days from sowing (DAS). The sum of dried plant fractions were used to calculate the total dry matter accumulation (g/plant). The growth attributes, viz. leaf area index (LAI), crop growth rate (CGR) and net assimilation rate (NAR) were measured according to the formula mentioned by Watson (1952).

LAI = unit leaf area per plant / plant ground area.

$CGR = (W_2 - W_1) / (t_2 - t_1)\ g / m^2 / week.$

$NAR = (W_2 - W_1)(\ln A_2 - \ln A_1) / (A_2 - A_1)(t_2 - t_1)\ g / m^2 / week$

Where: W_1, A_1 and W_2, A_2, refer to dry weight and leaf area at time t_1 and t_2 in week, respectively.

Days to flowering as the number of days from sowing to 50% flowering in each plot were recorded. At harvest, ten guarded plants were randomly taken from the two inner ridges of each experimental unit and the following characters were measured: plant height, head diameter in cm, number of seeds/head, 100-seed weight, seed husk percent, seed yield/plant, seed oil content (according to the method described by Comstock and Culberston, 1958). The heads of the two inner ridges of each sub-sub plot were harvested and seed yield was measured as kg/fed. Seed oil yield (kg/fed.) was determined by multiplying seed yield (kg/fed.) by seed oil content.

All the data collected were subjected to statistical analysis as described by Snedecor and Cochran (1980). The treatment means were compared according to Duncan's multiple range test (Duncan, 1955). All statistical analysis was performed using analysis of variance technique by means of "IRRISTAT" computer software package.

RESULTS AND DISCUSSION

A. Growth analysis and growth attributes :

Dry matter accumulation/plant, LAI, CGR and NAR values at all growth stages as influenced by sunflower cultivar, nitrogen rate, phosphorine biofertilizer and their interaction in 1998 and 1999 seasons are presented in Tables (1 and 2).

LAI at all growth stages in the two seasons, dry matter accumulation/plant at all growth stages in both seasons, except at the 1^{st} growth stage in 1998 season and NAR at all growth periods in 1998 and 1999 seasons, except at the first period (52-62 DAS) in the second season were sgnificantly affected by sunflower cultivar. On the other hand, CGR was not significantly affected by sunflower cultivar at all growth periods in both seasons, except at the second period (62-72 DAS) in the first season. Malabar cultivar significantly surpassed the other cultivars under study in these traits at the most growth stages. The superiority of Malabar is interpreted as such cultivar had greater photosynthetic area (LAI), which contribute to more photosynthates production and consequently increased dry matter accumulation/plant.Varietal differences in growth analysis and growth attributes of sunflower plant were also obtained by El-Hity *et al.* (1994a), El-Kalla *et al.* (1998), Abou-Khadrah *et al.* (2000) and Abou-Ghazala *et al.* (2001).

Table (1): Dry matter accumulation (g/plant), leaf area index (LAI), crop growth rate (CGR) and net assimilation rate (NAR) of sunflower plant at different growth stages as influenced by sunflower hybrid, nitrogen level and phosphorine during 1998 season.

Factor	Dry weight (g/plant)			LAI			CGR (g/m^2/week)		NAR (g/m^2/week)	
	Days from sowing						Growth period			
	52	62	72	52	62	72	52-62	62-72	52-62	62-72
Hybrid (A):										
Vidloc	45.96	66.66c	106.43c	1.29d	1.55d	1.61d	96.63	185.61c	46.04c	85.76b
Euroflour	47.62	68.71ab	111.56b	1.63c	1.76c	1.93c	97.09	199.93bc	51.84bc	103.25ab
Alamo	47.18	68.08b	114.07b	1.81b	1.99b	2.30b	97.52	214.63b	57.87b	110.81a
Malabar	47.91	69.36a	119.33a	2.03a	2.37a	3.11a	101.42	233.18a	68.25a	118.86a
F- test	N.S	**	**	**	**	**	N.S	**	**	*
Kg N/fed. (B):										
15	36.31c	48.84c	88.73c	1.54b	1.81b	2.03c	58.548c	186.16b	37.22c	102.34
30	46.17b	69.13b	115.63b	1.74a	1.91ab	2.30b	107.14b	217.01a	61.87b	105.97
45	59.02a	86.64a	134.18a	1.80a	2.04a	2.39a	128.89a	221.84a	68.91a	105.62
F- test	**	**	**	**	*	**	**	**	**	N.S
Phosphorine (C):										
Without Ph.	46.89b	67.80	112.50	1.69	1.92	2.23	97.56	208.61	55.61	104.16
With Ph.	47.44a	68.61	113.19	1.69	1.92	2.25	98.78	208.07	56.39	105.18
F- test	**	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	NS
Interaction:										
A ×B	N.S	N.S	N.S	**	NS	**	N.S	N.S	N.S	N.S
A × C	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
B × C	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
A × B × C	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

*,** and NS indicate $P<0.05$, $P<0.01$ and not significant, respectively. Means designated by the same latter are not significantly different at the 5% level, according to Duncan's Multiple range test.

Increasing nitrogen level up to 45 kg N/fed. significantly increased LAI, dry matter accumulation/plant, CGR and NAR at all growth stages. This fact is true in both seasons, but the differences between nitrogen level in NAR trait did not reach the level of significant at the second growth period in the first season. A significant increase in these traits accompanied each increament of applied nitrogen. This increase in LAI, dry matter accumulation, CGR and NAR might be due to the role of nitrogen fertilizers on structure of protein molecule, which is essential for biological activity and encouraged plant metabolism as well as growth of stems and leaves.

Table (2): Dry matter accumulation (g/plant), leaf area index (LAI), crop growth rate (CGR) and net assimilation rate (NAR) of Sunflower plant at different growth stages as influenced by sunflower hybrid, nitrogen level and phosphorine during 1999 season.

Factor	Dry weight (g/plant)			LAI			CGR ($g/m^2/week$)		NAR ($g/m^2/week$)	
	Days from sowing						Growth period			
	52	62	72	52	62	72	52-62	62-72	52-62	62-72
Hybrid (A):										
Vidoc	56.13c	74.07b	103.32b	1.33c	1.64b	1.81c	83.73	125.39	43.90	56.60b
Euroflour	59.40b	81.70a	109.13a	1.65b	2.09a	2.15b	89.69	127.03	46.11	59.31b
Alamo	62.49a	80.22a	108.92a	1.83b	2.15a	2.36a	89.91	136.51	56.59	59.77b
Malabar	61.16a	81.70a	109.76a	2.03a	2.16a	2.36a	104.03	136.92	58.74	76.41a
F- test	*	**	*	**	**	**	N.S	N.S	N.S	*
Kg N/fed. (B):										
15	50.69c	73.88c	87.62c	1.64c	1.92c	2.04c	77.93c	63.33c	42.21c	30.77c
30	60.43b	79.43b	107.78b	1.72b	2.00b	2.18b	88.60b	132.35b	49.20b	65.36b
45	68.26a	84.85a	127.95a	1.78a	2.11a	2.30a	108.99a	198.71a	62.61a	92.94a
F- test	**	**	**	**	**	**	**	**	**	**
Phosphorine (C):										
Without Ph.	50.69b	78.99b	107.27	1.70	1.99	2.15	93.31	130.18	50.29	62.28
With Ph.	60.43a	79.85a	108.29	1.72	2.03	2.19	90.37	132.74	52.38	63.76
F- test	*	*	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
Interaction:										
A × B	**	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
A × C	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
B × C	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
A × B × C	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

*,** and NS indicate $P<0.05$, $P<0.01$ and not significant, respectively. Means designated by the same latter are not significantly different at the 5% level, according to Duncan's Multiple range test.

The beneficial effects of nitrogen in increasing growth analysis and growth attributes were reproted by several investigators with sunflower crop such as (Kasem and El-Mesilhy, 1992a; El-Hity *et al.*, 1994a; Ibrahim and Helmy, 1995; Abou-Khadrah *et al.*, 2000 and Abou-Ghazala *et al.*, 2001).

Dry matter of sunflower plants was responsed significantly to the application of phosphorine at the 1st growth stage in the first season and at the 1st and 2nd growth stages in the second season. On the other hand, data showed that there were no significant difference due to application of phosphorine biofertilizer on LAI, CGR and NAR in both seasons. In this concern, Radwan (1997) on faba bean, Sherif *et al.* (1997) on lentil, Hanna (1999) on faba bean and Hamissa *et al.* (2000) on cotton, reported that in general, inoculation with mycorrhiza or other biofertilizer treatments increased DM accumulation/plant with these different field crops.

B. Agronomic characters :

The presented data in Tables (3 and 4) indicated that flowering took place earliear in Euroflour cultivar with a significant difference between this cultivar and the other three cultivars in the two seasons. Data indicated also that sunflower cultivar had a significant effect on plant height at harvest and head diameter in both seasons. Malabar cultivar gave the tallest plants and largest heads in 1998 and 1999 seasons. These results agree with those obtained by Keshta *et al.* (1993), Abou-Ghazala *et al.* (1996), Salama (1996), Mohamed (1997), El-Essawy and Mohamed (1998), Abou-Khadrah *et al.* (2000) and Abou-Ghazala *et al.* (2001).

Table (3): Effect of low nitrogen level and phosphorine on some characteristics of some sunflower hybrids during 1998 season.

Factor	Days to flowering	Plant height (cm)	Head diameter (cm)	Number of seeds/head	100-seed weight	Seed husk %
Hybrid (A):						
Vidoc	56.33a	148.11b	19.22d	1055.11b	5.97b	21.17d
Euroflour	51.6c	143.50c	19.67c	1116.50ab	6.26a	21.94c
Alamo	53.50b	144.66c	20.74b	1154.56a	6.28a	24.19a
Malabar	53.22b	150.41a	21.17a	1157.06a	6.31a	22.75b
F- test	**	**	**	**	*	**
Kg N/fed. (B):						
15	54.00	142.93c	18.33c	970.63c	5.81c	22.17b
30	53.50	146.75b	20.19b	1172.63b	6.21b	22.38b
45	53.50	150.32a	22.08a	1219.17a	6.60a	23.00a
F- test	NS	**	**	**	*	*
Phosphorine (C):						
Without Ph.	53.64	146.28	19.76b	1103.64b	6.12	22.27
With Ph.	53.69	147.06	20.64a	1137.97a	6.29	22.79
F- test	NS	NS	*	*	NS	NS
Interaction:						
A × B	NS	**	**	*	*	NS
A × C	NS	NS	NS	NS	NS	NS
B × C	NS	NS	NS	NS	NS	NS
A × B × C	NS	NS	NS	NS	NS	NS

*,** and NS indicate P<0.05, P<0.01 and not significant, respectively. Means designated by the same latter are not significantly different at the 5% level, according to Duncan's Multiple range test.

Plant height and head diameter significantly increased with increasing nitrogen fertilizer rate, while days to flowering did not significantly affected by nitrogen rate. In both seasons, each increament of nitrogen level resulted in a significant increase in plant height and head diameter. This stimulating effect of nitrogen may be related to the increase of metabolic components synthesized in the plant, which consequently increased the metabolites translocated from the source to the different plant organs. Similar results were reported by several researchers such as (El-Hity *et al.* (1994 b), El-Kalla *et al.* (1998), Abou-Khadrah *et al.* (2000), Basha (2000) and Abou-Ghazala *et al.* (2001).

Table (4): Effect of low nitrogen level and phosphorine on some characteristics of some sunflower hybrids during 1999 season.

Factor	Days to flowering	Plant height (cm)	Head diameter (cm)	Number of seeds/head	100-seed weight	Seed husk %
Hybrid (A):						
Vidoc	58.33a	158.29c	19.98c	1017.57b	6.20b	22.78c
Euroflour	52.28c	163.66b	20.09c	1103.71a	6.46a	23.19b
Alamo	55.44b	164.93b	20.41b	1130.87a	6.51a	23.78a
Malabar	55.33b	175.63a	21.88a	1139.56a	6.51a	23.19b
F- test	**	**	**	*	*	**
Kg N/fed. (B):						
15	55.13	161.85c	19.36c	966.74c	5.98c	22.17c
30	55.63	165.75b	20.59b	1128.78b	6.46b	23.25b
45	55.29	169.28a	21.82a	1198.26a	6.83a	24.29a
F- test	NS	**	**	**	*	**
Phosphorine (C):						
Without Ph.	55.47	165.19	20.06b	1077.66b	6.32	23.17
With Ph.	55.22	166.07	21.12a	1118.20a	6.53	23.31
F- test	NS	NS	*	**	NS	NS
Interaction:						
A × B	NS	**	**	NS	NS	NS
A × C	NS	NS	NS	NS	NS	NS
B × C	NS	NS	NS	NS	NS	NS
A × B × C	NS	NS	NS	NS	NS	NS

*,** and NS indicate $P<0.05$, $P<0.01$ and not significant, respectively. Means designated by the same latter are not significantly different at the 5% level, according to Duncan's Multiple range test.

Data show also that days to flowering and sunflower plant height at harvest time was responsed insignificantly to the application of phosphorine biofertilizer. However, application of phosphorine significantly increased head diameter in the two seasons. In this conection, Hamissa *et al.* (2000) observed that application of some biofertilizer on cotton plants did not affect plant height. On the other hand, Radwan (1996) found that application of some biofertilizer to sunflower increased head diameter.

C. Yield and its components :

The differences in number of seeds/head, 100-seed weight, seed husk percentage, seed yield/plant, seed yield/fed., seed oil content and oil yield/fed. among cultivars were significant or highly significant in both seasons, but the differences in seed oil content in the 2nd season and in seed oil yield/fed. In the 1st season did not reach the level of significant, (Tables 3, 4 and 5). Malabar cultivar gave the highest values of number of seeds/head, 100-seed weight, seed yield/plant, seed yield/fed. and seed oil yield/fed. without significant differences with Alamo and Eurflour cultivars at the most cases. Vidoc cultivar had the lowest seed husk percentage and was superior in seed oil percentage, while Alamo cultivar gave the highest seed husk percentage in the two seasons. Mohamed (1997), El-Essawy and Mohamed (1998), El-Kalla *et al.* (1998), Abou-Khadrah *et al.* (2000), Basha (2000) and Abou-Ghazala et al. (2001) observed varietal differences in yield and its components between different sunflower cultivars under their study.

Seed yield and its components were significantly increased with increasing nitrogen level up to 45 kg N/fed. Each increament of applied nitrogen increased significantly all traits of seed yield and its components. It was noted that the application of nitrogen affects growth attributes and yield components of sunflower plant. This reflects the important of nitrogen in building up the photosynthetic area of sunflower plants and consequently accumulation of more dry matter, which is reflected in seed yield and its components. Increasing nitrogen level up to 45 kg N/fed. gradually increased oil yield/fed., while it reduced seed oil content, but the differences in seed oil content did not reach the level of significant in the 1st season. Ibrahim and Helmy (1995), Salama (1996), El-Kalla *et al.* (1998) Abou-Khadrah *et al.* (2000), Basha (2000) and Abou-Ghazala *et al.* (2001) and many other investigators found that in general, increasing nitrogen level increased seed yield and its components of sunflower.

Application of phosphorine biofertilizer significantly increased number of seeds/head, seed and oil yields/fed. in both seasons as well as seed oil content in 1999 season only. While, phosphorine biofertilizer had no significant effect on 100-seed weight and seed husk percentage in the two seasons. In this concern, Radwan (1996) observed that application of some biofertilizer increased number of seeds/head and seed yield/plant in sunflower. Also, Radwan (1997) found that application of some biofertilizer to faba bean increased 100-seed weight, seed yield/plant and seed yield/fed.

Table (5): Effect of low nitrogen level and phosphorine on some characteristics of some sunflower hybrids during 1998 and 1999 seasons.

Factor	Seed yield (g/plant)		Seed yield (kg/fed.)		Seed oil %		Oil yield (kg/fed.)	
	1998	1999	1998	1999	1998	1999	1998	1999
Hybrid (A):								
Vidoc	63.50b	63.69b	913.11b	915.22b	42.63a	41.87	389.28	378.28b
Euroflour	70.50a	71.74a	1001.23a	1016.94a	40.52b	41.28	403.00	422.22a
Alamo	72.56a	73.42a	1027.28a	1044.83a	40.18b	40.51	404.17	423.56a
Malabar	73.33a	74.55a	1036.94a	1052.17a	40.22b	40.80	415.31	430.00a
F- test	**	**	**	**	*	NS	NS	*
Kg N/fed. (B):								
15	56.54c	57.62c	822.13c	840.67c	41.50	42.83a	334.90b	359.96c
30	72.83b	73.05b	1032.38b	1035.0b	40.71	40.31b	425.96a	420.33b
45	80.54a	81.88a	1129.46a	1146.21a	40.45	40.19b	447.96a	460.25a
F- test	**	**	**	**	NS	*	**	**
Phosphorine (C):								
Without Ph.	67.94b	68.30b	962.39b	970.19b	40.97	39.11b	385.74 b	379.53b
With Ph.	72.00a	73.41a	1026.92a	1044.39a	40.81	43.11a	420.140a	447.50a
F- test	*	*	*	*	NS	**	*	*
Interaction:								
A × B	NS	NS	NS	NS	NS	NS	NS	NS
A × C	NS	**	NS	NS	NS	NS	NS	NS
B × C	NS	NS	NS	*	NS	NS	NS	NS
A × B × C	*	**	**	NS	NS	NS	NS	NS

*,** and NS indicate P<0.05, P<0.01 and not significant, respectively. Means designated by the same latter are not significantly different at the 5% level, according to Duncan's Multiple range test.

D. Effects of interactions:

Data presented in Table (6) show a summary of interaction effects. In this Table, the highest values of the interaction among the three experimental factors [i.e., sunflower hybrid (A), N- level (B) and phosphorine biofertilizer (C)] on some characteristics are shown. The data in Table (6) reveal that the highest values of LAI at 52 and 72 DAS in the 1st season, dry matter accumulation/plant in the 2nd season, plant height at harvest and head diameter in both seasons as well as number of seeds/head in the 1st season were achieved when Malabar hybrid received 45 kg N/fed., while the highest value of 100- seed weight in the 1st season was obtained by Vidoc hybrid with 45 kg N/fed. It also clear from these data that application of phosphorine biofertilizer to Malabar hybrid resulted in the highest value of seed yield/plant, while the interaction between N- level and phosphorine gave the highest value of seed yield/fed. in the 2nd season. The data also reveal that the combination between Malabar hybrid, 45 kg N/fed. and application of phosphorine biofertilizer recorded the highest values of seed yield/plant in both seasons and seed yield/fed. in the 1st season.

Generally, the results indicated that Malabar hybrid with 45 kg N/fed. and application of phosphorine biofertilizer could be recommended for optimum sunflower seed yield per unit area under the environmental conditions of this study.

Table (6): Highest values of some sunflower characteristics as affected by the interaction of sunflower hybrid (A), N- level (B) and phosphorine as biofertilizer (C) in 1998 and 1999 seasons.

Characters	Interaction	Highest value	Treatments
1998 season			
LAI at 52 DAS	A X B**	2.12	Malabar X 45 kg N/fed.
LAI at 72 DAS	A X B**	3.38	Malabar X 45 kg N/fed.
Plant height at harvest (cm)	A X B**	154.57	Malabar X 45 kg N/fed.
Head diameter (cm)	A X B**	23.15	Malabar X 45 kg N/fed.
Number of seeds/head	A X B*	1253.3	Malabar X 45 kg N/fed.
100- seed weight	A X B*	6.85	Vidoc X 45 kg N/fed.
Seed yield (g/plant)	A X B X C*	85.67	Malabar X 45 kg N/fed. X with phosphorine
Seed yield (kg/fed.)	A X B X C **	1199.0	Malabar X 45 kg N/fed. X with phosphorine
1999 season			
Dry weight (g/plant) at 52 DAS	A X B**	72.68	Malabar X 45 kg N/fed.
Plant height at harvest (cm)	A X B**	179.65	Malabar X 45 kg N/fed.
Head diameter (cm)	A X B**	23.42	Malabar X 45 kg N/fed.
Seed yield (g/plant)	A X C** A X B X C**	76.49 86.63	Malabar X with phosphorine Malabar X 45 kg N/fed. X with phosphorine
Seed yield (kg/fed.)	B X C*	1174.8	45 kg N/fed. X with phosphorine

* and ** indicate significant at 5% and 1% level of significance.

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الملخص العربى

استجابة أربعة من هجن عباد الشمس لمستويات التسميد الأزوتى المنخفضة والفسفورين كسماد حيوى

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أجريت تجربتان حقليتان بالمزرعة البحثية لكلية الزراعة بكفرالشيخ- جامعة طنطا خلال موسمى الزراعة ١٩٩٨، ١٩٩٩م. نفذت التجارب لدراسة استجابة أربع هجن مبشرة من عباد الشمس وهى (فيدوك، ايروفلور، ألامو، مالابار) لثلاث مستويات من التسميد الأزوتى المنخفضة وهى (١٥، ٣٠، ٤٥ كجم أزوت/فدان) وكذلك معاملتين من التسميد الحيوى بالفسفورين وهما (بدون فسفورين كمقارنة، مع اضافة الفسفورين). وقد تم استخدام تصميم القطاعات المنشقة مرتين فى أربع مكررات. وتتلخص أهم النتائج المتحصل عليها فيما يلى:

١- أختلفت هجن عباد الشمس فيما بينها معنويا فى صفات النمو وكذلك المحصول ومكوناته. وقد تفوق الهجين "مالابار" على الهجن الثلاثة الأخرى فى المادة الجافة المتجمعة للنبات، دليل مساحة الورق LAI ، صفة معدل نمو المحصول CGR، صفة معدل التمثيل الصافى NAR وكذلك كل صفات المحصول ومكوناته.

٢- أدت زيادة مستويات التسميد الأزوتى حتى ٤٥ كجم أزوت للفدان الى زيادة معنوية فى كل الصفات المدروسة فيما عدا صفة محتوى البذور من الزيت ، حيث أدت زيادة معدلات التسميد الأزوتى الى نقص محتوى البذور من الزيت ولكن الاختلافات بين مستويات التسميد الأزوتى فى تلك الصفة لم تصل لحد المعنوية فى الموسم الأول من الدراسة.

٣- أدت اضافة الفسفورين كمخصب حيوى الى زيادة معنوية فى كل من وزن المادة الجافة المتجمعة بالنبات فى بعض مراحل النمو، قطر القرص، عدد البذور بالقرص، محتوى البذور من الزيت، محصول البذرة للنبات وكذلك محصول البذرة والزيت للفدان. ومن ناحية أخرى لم تظهراضافة الفسفورين أى تأثير معنوى على كل من دليل مساحة الورقة LAI، معدل نمو المحصول CGR، معدل التمثيل الصافى NAR ، عدد الأيام حتى التزهير، ارتفاع النبات عند الحصاد، وزن الـ١٠٠ بذرة وكذلك % للقشرة.

٤- عامة تشير النتائج المتحصل عليها أن زراعة الهجين "مالابار" وتسميده بمعدل ٤٥ وحدة أزوت واضافة الفسفورين كسماد حيوى يمكن أن يوصى به للحصول على أعلى محصول بذور من عباد الشمس فى وحدة المساحة تحت ظروف هذا البحث.