Sunflower response to mineral nitrogen, organic and bio-fertilizers under two different levels of salinity

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ABSTRACT

This investigation was carried out during the two summer growing seasons of 2005 and 2006 at two locations in the north-east of the delta of Egypt. The first site (S1) is characterized by a good clay soil with fresh irrigated water while the second site (S2) has a salt-affected soil and is irrigated with a mixture of fresh and drained water. Two open pollinated cultivars of sunflower (Sakha 53 and Giza 102) were used. Seven different packages of the combinations of bio (cerealin), organic and mineral nitrogen fertilizers were used as follows: T1 is the recommended chemical nitrogen fertilize (45 Kg N/fad) (fad= Faddan = 4,200 m^2), T2 (1/2 N +30 m^3/fad of organic fertilizer) , T3 (bio fertilizer + 1/2 T1), T4 (bio fertilizer + 30 m^3 /fad organic fertilizer + 1/2 of T1), T5 (bio fertilizer + 30 m^3/fad organic fertilizer + 1/4 of T1), T6 (30 m^3 /fad of organic fertilizer + 1/2 of T1) and T7 (bio fertilizer + 30 m^3 /fad organic fertilizer). The results obtained showed that the application of farmyard manure in T4 has increased yield and yield component traits compared with the control treatment at S1 location. Head diameter, number of seeds per head, 100 seed weight, seed yield per plant and seed yield per plot were increased by 3.4, 13.4, 4.7, 12.8 and 16.8%, respectively, compared with the control treatment. T5 recorded the next rate of increase for the same traits by 2.2, 5.8, 5.8, 8.7 and 11.2%, respectively. The application of mineral nitrogen or organic manure has increased protein content in the good soil, while the mineral nitrogen alone (45kg N/fad) surpassed all other treatment in the salt-affected soil.

Key words: bio-fertilizer – mineral nitrogen – organic fertilizer – salinity

INTRODUCTION

Sunflower (*Helianthus annuus* L.) was chosen in this investigation as it is considered to be one of the most important promising oil crops in Egypt and it could be successfully grown in a great range of climatic conditions and soils. It could also play an important role in the cultivation of the new reclaimed lands, which are suffering drought, high temperatures and salinity effects. Organic and bio fertilizers were studied in this investigation as a replacement of part of the chemical nitrogen to reduce the total cost of cultivation and the chemical nitrogen pollution, and to improve the soil physical and chemical structure.

Singh et al. (1995) pointed out that oil content in sunflower seeds was reduced as the nitrogen increased from 40 to 80 kg N/ha. Singh et al. (1998) studied the content and uptake of nutrients by the sunflower crop as affected by *Azotobacter*, farmyard manure and NP levels. They showed that application of farmyard manure at 10 ton/ha, significantly improved the nitrogen and phosphorus contents in seed in both seasons and potassium content in second year only. In addition, they reported that the seed yield of sunflower was significantly higher with the farmyard manure (FYM) than with no FYM and *Azotobacter* inoculation treatments. El-Bana (2000) found a significant increase in oil yield per faddan (fad= Faddan = 4200 m^2) caused by the addition of organic matter and bio fertilizer (Cerealin). The interaction between organic matter application and inoculation with cerealin significantly increased seed oil content. Abou-Khadrah et al. (2002) pointed out that 100-seed weight, seed yield/plant and seed yield/fad were significantly increased by increasing nitrogen levels up to 45 kg N/fad.

MATERIALS AND METHODS

This investigation was carried out during the two summer growing seasons of 2005 and 2006 at Gamalia Dakahlia and at EL-Serw Agricultural Research Station in north east of the delta of Egypt. The first site (S1) has a good clay soil, while the second one (S2) is characterized by a salt-affected soil which is irrigated with a mixture of fresh and agricultural drained water.

Seven different packages of combinations of bio fertilizer, as cerealin, organic fertilizer as a farmyard manure (FYM) and mineral nitrogen (N) fertilizer besides the recommended rate of nitrogen were used as

follows: T1 (45 Kg N/fad as the recommended chemical nitrogen fertilizer), T2 (30 m^3/fad FYM +1/2 T1), T3 (Bio fertilizer +1/2T1), T4 (Bio fertilizer +30 m^3/fad FYM + 1/2T1), T5 (Bio fertilizer +30 m^3/fad FYM + 1/4T1), T6 (15 m^3 /fad FYM + 1/2T1) and T7 (Bio fertilizer + 30 m^3 /fad FYM) (fad= Faddan = 4200 m^2).

The nitrogen fertilizer used, was a form of ammonium nitrate (33.3% N). The analysis of the farmyard manure (FYM), which was used as an organic fertilizer during both seasons (2005 and 20006), were: Moisture = 30%, 34 % ;C/N ratio = 11.92, 12.04; Organic matter = 10.40, 10.63 %; N = 0.51, 0.58%; P = 0.30, 0.27%; K = 3.74, 3.96 %; EC dS/m = 3.12, 3.27 and PH = 7.51, 8.04, respectively.

The soil salinity was 832 and 858 ppm at the site of Gamalia (S1; conventional soil) in both seasons, respectively, while at EL-Serw Agric. Research Station (S2; saline-affected soil) it was of 3140 and 3789 ppm, respectively. The electric conductivity of the irrigated water for S1 was 0.40 and 0.37 dS/m, while in S2 it was 1.60 and 1.51 dS/m for the first and the second seasons, respectively.

Seven random plants from the inner rows of each sub plot were taken at harvest time to determine plant height, number of leaves per plant, stem diameter, head diameter, number of seeds per head, 100-seed weight and seed yield per plant and the whole seed yield per plot were recorded.

The experiment plot contained 4 ridges (0.60 m width x 4 m long) and seeds were sown in hills (30 cm apart) on one side of each ridge and surface irrigation was used.

All data were subjected to the appropriate statistical analysis of variance as outlined by Snedecor and Cochran (1980). Data of the two seasons were compared by using the Least Significant Difference Test (LSD).

RESULTS AND DISSCUSION

The means of vegetative growth traits, yield and yield components, and oil and protein contents of the two varieties of the combined data over the two locations are presented in Tables 1, 2 and 3.

Vegetative growth traits

At the first site (S1), which was characterized with good soil, data obtained (Table 1) indicated that plant height under the fertilization treatment T4 showed a significant superiority over the control treatment (45 kg N/fad) and, to different extents, over the other treatments. The tallest plant (236 cm) was recorded with the higher FYM application (T4 treatment) followed by T5 treatment and the shortest plants were obtained with T7. On the other hand, at El-Serw site (S2), it was found that, with the exception of T2 treatment, plant height was significantly less under all fertilization treatments than under the control (T1) treatment. Data also revealed that the number of leaves/plant was significantly affected by all treatments at site S1 only. The highest and lowest values were observed with T4 and T7, respectively, while, there was no significant effect at El-Serw site (S2). These results indicate that the differences between the treatments were not great enough to reach the significant level. Stem diameters of plants were also significantly affected at both locations. T4 treatment recorded the highest value for this trait (Table 1) and showed a significant superiority over the other treatments tested. In contrast, the treatment consisting of the sole mineral nitrogen was the superior one in the second site (S2). These results could be attributed to the negative effects of salinity on the bio and organic fertilizers. At Gamalia (S1), data presented in Table 1 indicated that the highest number of days to 50 % flowering was recorded under the fertilization treatment T4, while T7 (bio. + 30 m^3 OM) recorded the lowest number. In contrast, at El-Serw (S2) location was observed the lowest number of days to 50% flowering (53.9) under the fertilization treatment T7. This means that the response of this trait to the seven selected fertilization treatments at the two locations was not the same and revealed contradictory findings.

Yield and yield component traits

The results presented in Table 2 showed that at Gamalia (S1) the application of organic manure and/ or cerealine to this good soil significantly increased head diameter, number of seeds per head, seed yield per plant and per plot. These increases were more pronounced under T4, but the absence of bio or organic fertilizers reduced the values of the mentioned traits in relation to the control treatment as shown in T2 or T3. Moreover, the rate of these two fertilizers alone gave the lowest values of the same traits and could not compensate for the absence of mineral nitrogen (45kg N/fad). These results indicate that the used rates of the bio and organic fertilizers did not meet sunflower requirement of nitrogen. The data also showed that the highest value of 100 seed weight was obtained under T5 treatments, in which the rate of the mineral nitrogen was reduced, whereas at S2, the T1 (45 kg N/fad) was superior in all studied traits except for the 100 seed weight.

Table 1. Effect of selected fertilization treatments on some vegetative growth traits at Gamalia and El-Serw locations (combined analysis of the two seasons).

Treatments	Plant height cm.		leaves /plant (N0)		Stem diameter(cm)		Days to flowering	
	S1	S2	S1	S2	S1	S2	S1	S2
T1 (45 kg N/fad)	227	126	31.1	27.2	2.22	1.55	56.8	55.7
T2 (1/2 N + 30 m^3 fym)	222	126	31.3	26.4	2.24	1.50	56.8	54.6
T3 (1/2 N. +30m^3 fym)	224	119	31.0	26.4	2.36	1.49	55.5	56.1
T4 (1/2 T1 + bio + 30 m^3org.)	236.	116	33.6	25.0	2.50	1.43	57.8	53.9
T5 (1/4 N + 30 m^3 fym)	228	118	31.8	24.8	2.38	1.21	56.2	56.6
T6 (1/2 T1 + 15 m^3 fym)	225	114	30.9	27.2	2.41	1.32	56.8	54.6
T7 (bio. + 30 m^3 fym)	212	117	30.7	26.6	2.27	1.40	55.3	56.8
L.S.D. $_{0.05}$	6.1	5.9	1.57	-	0.211	0.149	0.684	1.01

S1 = The good clay soil at Gammalia; S2 = The salt-affected soil at El-Serw

Table 2. Combined data of 2005 and 2006 seasons on some yield and yield component traits under different fertilization treatments.

Treatments	Head diameter (cm)		Number of seeds/head		100 seed weight (gm)		Seed yield /plant (gm)		Seed yield /Plot (kg)	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
T1 (45 kg N/fad)	22.0	17.4	1119.2	982.0	6.85	6.93	80.0	67.5	5.33	4.44
T2 (1/2 N + 30 m^3 fym)	21.4	17.2	1170.8	870.0	7.13	6.88	85.8	62.2	5.71	4.26
T3 (1/2 N. +30m^3 fym)	21.6	16.6	1157.3	875.2	6.91	5.79	83.2	53.1	5.69	3.65
T4 (1/2 T1+ bio+30 m^3org)	22.7	16.7	1269.2	893.3	7.17	6.53	90.2	60.6	6.22	4.02
T5 (1/4N+30 m^3 fym)	22.5	16.6	1188.2	856.7	7.27	6.53	87.6	57.1	6.00	3.79
T6 (1/2 T1+ 15 m^3 fym)	21.3	16.8	1156.2	862.5	6.89	6.27	83.2	56.6	5.65	3.75
T7 (bio. + 30 m^3 fym)	20.1	16.4	967.1	738.8	6.69	6.77	66.6	515	4.53	3.55
L.S.D. $_{0.05}$	1.01	0.68	62.8	62.6	0.562	0.359	4.74	3.92	0.151	0.164

Table 3. Combined data of 2005 and 2006 seasons on some quality traits under different fertilization treatments at Gamalia and El-Serw locations

Treatments	Seed oil (%)		Seed protein (%)	
	S1	S2	S1	S2
T1 (45 kg N/fad)	43.1	41.1	16.5	16.3
T2 (1/2 N + 30 m^3 fym)	43.3	40.2	16.9	15.9
T3 (1/2 N. +30m^3 fym)	42.2	41.4	16.1	15.6
T4 (1/2 N + bio.+30m^3fym)	43.0	40.6	17.0	16.3
T5 (1/4N+30 m^3org	41.7	39.9	16.1	16.1
T6 (1/2 N. + 15 m^3 fym)	41.3	42.9	16.0	15.8
T7 (bio. + 30 m^3 fym)	42.5	41.2	17.2	16.6
L.S.D. $_{0.05}$	0.611	0.524	0.416	0.418

The results indicated that the stimulatory effect of the combination of the three fertilizer sources, i.e mineral nitrogen, FYM and cerealine at site 1 in the previous treatments on the seed yield and yield components traits may be attributed to increasing the meristemic and enzymatic activities which encourage plant growth. Meanwhile, the release of N of the FYM and cerealine were not enough to compensate for the 50% reduction of chemical nitrogen dosage in S2 location. The salinity may also negatively affect the microorganism activity For this reason, the full dosage of N (45kg N/fad) was superior in the salty soil. These results are in agreement with those obtained by Singh et al. (1998) and Abou-Khadrah et al. (2002).

Quality traits

The results at S1, presented in Table 3, indicated that most seed oil percentages obtained under fertilizer treatments were lower than those obtained under control treatment T1, especially T4 and T6 by 0.2 and

4.2%, respectively, while T2 showed an increment over the control treatment by 0.4%. At site2, data also indicated that seed oil percentage under treatments T6, T3 and T7 showed an increase over the control treatment which was 4.5, 0.8 and 0.4% respectively. However, for fertilizer treatments T4 and T5 oil contents were lower than the obtained under control treatment T1 by 1.0 and 2.9%, respectively. These results indicated that the highest nitrogen fixation gave the highest protein content and the lowest oil content at site 1.

These results may be due to the effect of organic manure by improving the physical structure of the soil and increasing available nitrogen, which reflects the greater growth and, consequently, more absorption of nitrogen and more crude protein synthesis. These results are in line with those obtained by El-Bana (2000) and El-Sadek (2005).

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