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EFFECT OF NITROGEN FERTILIZER LEVELS AND ITS APPLICATION TIMES ON SOYBEAN PRODUCTIVITY

Knany, R.E.; El-Saady, A.S.M. and Atia, R.H.
Soils, Water and Environment Res. Inst., Agric. Res. Center, Giza, Egypt

ABSTRACT

Two field experiments were carried out at Sakha Agriculture Research Station Farm during two successive summer seasons of 2002 and 2003 using soybean (*Glycine max* L.) variety Giza 111. Split plot design was used. The main plots were assigned to three nitrogen application times: 1- applicating of nitrogen fertilizer with the first irrigation (T_1), 2- applicating of nitrogen fertilizer with the second irrigation (T_2), 3- applicating of nitrogen fertilizer with the third irrigation (T_3). The sub plots were allotted for four nitrogen levels i.e., 0 (N_0), 20 (N_{20}), 40 (N_{40}) and 60 (N_{60}) kg N fed.$^{-1}$ to investigate the effect of nitrogen application times and levels on soybean seed, straw, protein and oil yields kg fed.$^{-1}$ as well as residual available N and P in the soil. The plot area was 15 m^2.

The obtained results show that nitrogen application times high significantly affected seed, straw, oil and protein yields. T_1 treatment gave the highest straw yield in both seasons. While T_2 treatment gave the highest seed yield (996 and 965 kg fed^{-1}), oil yield (231 and 287 kg fed^{-1}) and protein yield (356 and 346 kg fed^{-1}) in the first and second seasons, respectively. Nitrogen levels high significantly affected seed, straw, oil and protein yields. The highest values were obtained with N_{60} treatment.

Applicating of nitrogen fertilizer with the second irrigation T_2 increased nitrogen use efficiency. On the other hand, increasing nitrogen fertilizer level led to clear decrease in nitrogen use efficiency values. T_3 treatment gave the highest nodules number, nodules dry weight and the residual N, P in the soil. N_{60} treatment had the highest nodules number and nodules dry weight.

INTRODUCTION

Soybean is a promise crop in Egypt. It has been a valuable source for high energy, high protein and other nutrients to human and their livestock.

Some of the most exciting research taking place today involves the use of soybean in preventing cancer, reducing the risk of coronary heart disease and controlling glucose levels in diabetic patients.

Adding soybean or soyfood as a part of our diet could improve our health (Ali, 1988). Soybean is one of legumes are of special agronomic and economic significance because of their ability to fix N_2 symbiotically in many cropping systems. It fixes average rates of 57-94 kg N_2 fixed ha^{-1} (Hardy *et al.,* 1971, Weber *et al.,* 1971, Keyser and Fudi, 1992 and El-Haddad *et al.,* 1998).

Most of the biologically N_2-fixed by soybean plants accumulates during 30 days period, between 50 and 80 days from planting (Yanni *et al.,* 1987, Danso *et al.,* 1990 and El-Haddad *et al.,* 1998). One of the main findings associated with soybean production is that Egyptian soils are high in pH and devoid of the bacterial endophytes *Rhizobium japonicum* which nodulate it (El-Haddad *et al.,* 1998).

Symbiotic N_2 fixation is dependent on pedoclimatic factors as well as the host cultivar and Rhizobium. Both salinity and drought stress inhibit symbiotic N_2 fixation rates in legume nodules (Serraj and Sinclair, 1999).

Soybean could obtain 25-75% of plant nitrogen from the soils with the balance supplied from symbiotic fixation. Before active nodules form on roots, all nitrogen will supplied to the plant from soil. Under some conditions, like low organic matter and low residual nitrogen the supply of nitrogen from the soil and nodules not be adequate. In this cases soybean yield can be increased by applying nitrogen fertilizer (Marschner, 1995).

It is clear that a low rate of combined nitrogen may result in increasing plant growth and symbiotic N_2 fixation presumably by giving the plant an early booster of nitrogen which makes it healthier to support the N_2 fixation symbiosis (Eaglesham *et al.*, 1983). Conversely application of a high rate of N fertilizer to soybean has been generally reported to reduce the level of N_2 fixation (La Favre and Eaglesham, 1987).

The objective of the present study is to evaluate the effect of mineral nitrogen fertilizer level and its application times on soybean growth and yields under the Egyptian soils conditions.

MATERIALS AND METHODS

Two field experiments were carried out at Sakha Agricultural Research Station Farm during the agricultural summer seasons of 2002 and 2003 using soybean (*Glycine max* L., cv. Giza 111) seeds rate 45 kg fed^{-1} was sown, 3-4 seeds in the hill, 20 cm between the hills and 60 cm between the ridge April, 23 and 14 in the first and second season, respectively to investigate effect of nitrogen fertilizer levels and application times on soybean productivity. The plants were thinned to 2 plants in the hill 20 days after planting. Split plot design was used in four replicates. The main plots were randomly assigned to three application times of nitrogen fertilization of 1- applicating the nitrogen fertilizer, 21 days after planting with the first irrigation (T_1), 2- applicating the nitrogen fertilizer 35 days after planting with the second irrigation (T_2), and 3- applicating the nitrogen fertilizer 50 days after planting with the third irrigation (T_3). The sub plots were randomly assigned to four nitrogen levels of 0 (N_0), 20 (N_{20}), 40 (N_{40}) and 60 (N_{60}) kg $fed.^{-1}$ as ammonium nitrate 33%. The plot area was 15 m^2. The main properties of the experimental soils were 3 and 3.8 dSm^{-1} in EC, 8 and 8.2 in pH, 27 and 22 mg kg^{-1} in available N, 5.9 and 5.7 mg kg^{-1} in available P and 270 and 250 mg kg^{-1} in available K in the first and second season, respectively and clayey in textures. The experimental soil characteristics were determined according to Black *et al.* (1965).

The other recommended agricultural practices were followed. At soybean harvest the seed and straw yields were weighted. Seed samples were collected, oven dried, fine grinded and wet-digested. Total N was determined by kjeldahl method, total P colorimetrically were determined in the digestion according to Jackson (1958). Protein (%) were calculated by multiplying N% by 6.25 and calculated as kg fed^{-1}. Oil was determined in the seeds according to A.O.A.C. (1975) and calculated as kg fed^{-1}. Nitrogen use efficiency for the added N was calculated as kg seeds per kg N fertilizer. At 80 days after planting single plants were collected from the treatments for determining the nodules number on the plant roots and their dry weight.

At harvest, soil samples were collected and residual available N and P were evaluated. The results were statistically analysed according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1. Seed yield:

The results in Table 1 show that the time nitrogen significantly affected seed yield in the first season. In the second season the effects were highly significant. The highest seed yield values of 996 and 965 kg fed^{-1} were obtained with T_2 treatment in the first and second season, respectively. This may be due to that the second irrigation time was during the vegetative period which need nitrogen fertilizer rather than that of the fixed symbiotically.

Nitrogen fertilizer levels high significantly affected seed yield in both seasons. The highest mean values of 1094 and 1102 kg fed^{-1} were obtained with N_{60} in the first and second season, respectively. On the other hand the lowest mean values of 691 and 617 kg fed^{-1} were observed with N_0 (check treatment) in the first and second season, respectively (Table 2). Effects of the interaction between application times of nitrogen and its levels on soybean seed yield (Table 3) were significant in the first season and highly significant in the second season. The highest values of 1258 and 1270 kg fed^{-1} were obtained with T_2 and N_{60} treatment in the first and second season, respectively. On the other hand, the lowest values of 691 and 617 were recorded with N_0 this may be due to that the experimental soils had high pH values (8.0 and 8.2) which affected nodulation process and nodules efficiency. Application the nitrogen during the vegetative growth stage enhance plant growth and increase the seed yield. Similar results were reported by Parsons *et al.*, 1993 and Maschner, 1995.

Table 1: Effect of the nitrogen application times on soybean seed, , oil and protein yields kg/$fed.^{-1}$ in the first and second seasons.

N-application time	Seed yield		Straw yield		Oil yield		Protein yield	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
T_1	906	836	1079	1033	216	244	308	288
T_2	996	965	959	1014	231	287	356	346
T_3	945	851	950	987	197	267	271	273
F-test	*	**	*	*	**	**	**	*

T_1 = Nitrogen was applied with the first irrigation (21 days after planting).
T_2 = Nitrogen was applied with the second irrigation (35 days after planting).
T_3 = Nitrogen was applied with the third irrigation (50 days after planting).

Table 2: Effect of the nitrogen fertilization levels on soybean seeds, straw, oil and protein yields kg/fed.$^{-1}$ in the first and second seasons.

Nitrogen levels	Seed yield		Straw yield		Oil yield		Protein yield	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
N_0	691	617	802	839	158	187	229	206
N_{20}	859	839	904	950	205	248	288	278
N_{40}	1020	978	1126	1126	244	291	351	344
N_{60}	1094	1102	1151	1130	252	338	379	381
F-test	**	**	*	**	**	**	**	**
L.S.D. 0.05	77.3	39.2	101.2	115.5	18.8	17.8	34.8	15.1

N_0 = Zero nitrogen
N_{20} = 20 kg N fed^{-1}
N_{40} = 40 kg N fed^{-1}
N_{60} = 60 kg N fed^{-1}

Table 3: Effect of the interactions between nitrogen fertilizer levels and application times on soybean seed, straw, oil and protein yields kg/fed.$^{-1}$.

Treatments	Seed yield		Straw yield		Oil yield		Protein yield	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
T_1 N_0	691	617	802	814	158	177	235	213
T_1 N_{20}	925	839	1061	974	224	227	323	291
T_1 N_{40}	987	851	1159	1147	247	257	330	303
T_1 N_{60}	1024	1036	1295	1196	236	314	344	346
T_2 N_0	691	617	802	851	158	189	231	205
T_2 N_{20}	925	802	765	987	219	245	321	278
T_2 N_{40}	1110	1172	1172	1158	263	337	421	445
T_2 N_{60}	1258	1270	1060	1061	289	375	4451	455
T_3 N_0	691	617	802	851	164	194	221	200
T_3 N_{20}	728	876	888	888	172	273	221	265
T_3 N_{40}	962	913	1048	1085	220	279	301	285
T_3 N_{60}	999	999	1098	1122	230	323	341	341
F-test	*	**	N.S	N.S	*	**	*	**
LSD 0.05	133.9	68.1			32.6	30.8	60.3	8.8

2. Straw yield:

Results tabulated in Table 1 show that the application times of nitrogen fertilizer significantly affected soybean straw yield in both seasons. The highest mean values of 1079 and 1033 kg fed^{-1} were obtained with T_1 treatment. On the other hand, the lowest values of 950 and 987 kg fed^{-1} were observed with T_3 treatment in the first and second season, respectively. This may be due to the application of fertilizer with the first irrigation which gave the chance for increasing the vegetative growth in long period.

Nitrogen fertilizer levels had significant effects on straw yield in the first season. In the second season the effects were highly significant. The highest mean values of 1151 and 1130 kg fed^{-1} were obtained with N_{60}

treatment in the first and second season, respectively (Table 2). From the data in Table 2 no clear variance between N_{40} and N_{60} treatments in straw yield in both seasons. On the other hand, the lowest mean values of 802 and 839 kg fed^{-1} were observed with N_0 treatment in both seasons. From the data tabulated in Table 3 it is clear that no significant effects on soybean straw yield due to the interaction between nitrogen fertilizer levels and their application times in both seasons. These results could be supported with those obtained by Eaglesham *et al.*, 1983; Silsbury *et al.*, 1986 and Maschner, 1995.

3. Oil yield:

It is quite obvious from the data presented in Table 1 that, soybean oil yield high significantly affected by nitrogen application time in both seasons. The highest oil yield (231 and 287 kg fed^{-1}) were obtained with T_2 treatment in the first and second seasons, respectively. The lowest oil yield was recorded with T_3 in the first season and with T_1 in the second season. This may be due to oil yield is related to seed yield.

Oil yield was high significantly affected by nitrogen fertilizer levels in both seasons. The highest oil yield was obtained with N_{60} treatment in both seasons, i.e. 252 and 338 kg fed^{-1}. The variance between N_{40} and N_{60} was non significant in the first season. On the other hand, the lowest oil yield was recorded with N_0 in both seasons (Table 2).

Data presented in Table 3 show that the interaction between nitrogen application times and levels significantly affected oil yield in the first season. In the second season the effects were highly significant. The highest values (289 and 375 kg fed^{-1}) were obtained with T_2 and N_{60} (application of 60 kg N fed^{-1} before the second irrigation). On the other hand the lowest oil yield (158 and 177 kg fed^{-1}) were observed with check treatment in the first and second seasons, respectively. The previous data show that the oil yield was related to seed yield. These results are in agreement with those obtained by Knany *et al.*, 2000.

4. Protein yield:

Data presented in Table 1 show that nitrogen application times high significantly affected protein yield in the first season. In the second season the effects were significant. The highest values were 356 and 346 kg fed^{-1} obtained with T_2 treatment.

Nitrogen levels high significantly affected soybean protein yield in both seasons. The highest values, 379 and 381 kg fed^{-1} were observed with N_{60} treatment in the first and second seasons, respectively (Table 2).

The interaction between nitrogen levels and application times significantly affected protein yield in the first season. In the second season the effect was highly significant. The highest values of 451 and 455 kg fed^{-1} were obtained with T_2 and N_{60} treatment in the first and second season, respectively. This may be due to that T_2 and N_{60} treatment increased seed yield and nitrogen % in the seed, which causes increasing protein % and protein yield kg fed^{-1}. Similar results were obtained by Hardy *et al.*, 1971.

5. Hundred seeds weight:

Data tabulated in Table 4 show that nitrogen applicating with the third irrigation had the highest values of 100 seeds weight (16.7 and 15.2 g) in the first and second seasons, respectively. On the other hand the lowest values were observed with T_2 treatment in both seasons.

Nitrogen fertilizer levels clearly affected hundred seed weight, the highest values (16.7 and 14.9 g) were obtained with N_0 treatment. On the other hand, the lowest value 14.3 was detected with N_{60} treatment in both seasons (Table 5). The interaction between nitrogen application times and levels clearly effectrf 100 seeds weight. The highest values (17.5 and 15.8 g) were observed with T_3 and N_{40} treatment in the first and second seasons, respectively. This may be due to applicating the nitrogen fertilizer in the late time enhance seed filling. Similar results were reported by Eaglesham *et al.*, 1983.

Table 4: Effect of nitrogen fertilization times on soybean 100 seeds weight g, phosphorus content of the seeds kg/fed.$^{-1}$, nitrogen content kg fed^{-1} and nitrogen use efficiency.

N-application time	100 seeds weight		P-content		N-content		N-use efficiency	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
T_1	15.2	14.4	4.09	4.18	49.3	46.1	22.7	20.9
T_2	14.7	13.4	4.14	4.35	57.0	49.2	24.9	24.1
T_3	16.7	15.2	4.23	4.68	43.4	43.7	21.1	21.3

Table 5: Effect of nitrogen fertilization levels on soybean 100 seeds weight g, phosphorus content of the seeds kg/fed.$^{-1}$, nitrogen content kg/fed.$^{-1}$ and nitrogen use efficiency.

Nitrogen levels	100 seeds weight		P-content		N-content		N-use efficiency	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
N_0	16.7	14.9	3.15	3.09	36.6	33.0	-	-
N_{20}	15.6	14.5	3.89	4.20	46.1	44.5	43.0	42.0
N_{40}	15.5	14.3	4.08	4.89	52.2	55.0	25.5	24.5
N_{60}	14.3	14.3	4.93	5.51	60.6	61.0	18.2	18.4

6. Phosphorus content in the seeds:

Results in Table 4 show that nitrogen application times affected phosphorus content. The highest values (4.23 and 4.68 kg fed^{-1}) were obtained with T_3 treatment in the first and second seasons, respectively. Nitrogen levels affected phosphorus content in both seasons. The highest values (4.93 and 5.51 kg fed^{-1}) were observed with N_{60} treatment in the first and second season, respectively (Table 5). Table 6 show the effect of the interaction between nitrogen levels and their application times on P-content of soybean seeds. The highest values (5.03 and 5.72 kg fed^{-1}) were obtained with T_2 and N_{60} treatment in the first and second seasons, respectively. Similar results were reported by Knany *et al.*, 2000 who found that increasing nitrogen fertilizers led to clear increase of phosphorus uptake by soybean seeds.

7.Nitrogen content in the seeds and N-use efficiency:

Data presented in 4 clearly show that nitrogen application times affected nitrogen content of the seeds and nitrogen use efficiency in both seasons. The highest nitrogen content values (57 and 49.2 kg N fed^{-1}) were obtained with T_2 treatment in the first and second season, respectively. The lowest values of 43.4 and 43.7 kg fed^{-1} were observed with T_3 treatment. Nitrogen use efficiency had the same trend in N-content. The highest nitrogen use efficiency values of 24.9 and 24.1 kg seed/kg fertilizer were obtained with T_2 treatment.

Nitrogen content and nitrogen use efficiency were clearly affected by nitrogen levels. The highest nitrogen content values (60.6 and 61.0 kg fed^{-1}) were detected with N_{60} treatment in the first and second season, respectively (Table 5). On the other hand, the lowest values of 36.6 and 33.0 kg fed^{-1} were observed with check treatment.

Table 5 clear that increasing nitrogen level led to decrease nitrogen use efficiency in both seasons. The interaction between nitrogen application times and levels affected nitrogen content and nitrogen use efficiency (Table 6). The highest N-content values were 72.2 and 72.8 obtained with T_2 and N_{60} treatment. The highest N-use efficiency values were 46.3 and 42.1 recorded with T_2 and N_{20} treatment in the first and second season, respectively. These results could be enhanced with those obtained by El-Haddad *et al.*, 1998 and Knany *et al.*, 2000.

Table 6: Effect of the interaction between nitrogen fertilization times and nitrogen levels on soybean 100 seeds weight g, phosphorus, content of the seeds kg fed^{-1}, nitrogen content kg/$fed.^{-1}$ and nitrogen use efficiency.

Treatments	100 seeds weight		P-content		N-content		N-use efficiency	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
$T_1 N_0$	16.7	14.0	3.46	3.09	36.6	33.0	-	-
$T_1 N_{20}$	15.8	14.7	4.17	4.20	52.0	46.6	46.3	42.0
$T_1 N_{40}$	14.8	13.8	4.94	4.26	52.8	48.5	24.7	21.3
$T_1 N_{60}$	13.0	14.7	5.12	5.18	55.0	55.4	17.1	17.3
$T_2 N_0$	16.7	14.0	3.46	3.09	36.6	63.3	-	-
$T_2 N_{20}$	13.7	13.7	4.63	3.61	51.4	44.5	46.3	42.1
$T_2 N_{40}$	14.2	13.3	3.89	5.28	67.4	71.2	27.8	29.3
$T_2 N_{60}$	13.8	13.1	5.03	5.72	72.2	72.8	21.0	21.2
$T_3 N_0$	16.7	14.0	3.46	3.09	36.6	33.0	-	-
$T_3 N_{20}$	17.2	15.2	2.91	4.82	35.4	42.4	36.4	40.9
$T_3 N_{40}$	17.5	15.8	3.85	4.57	48.2	45.6	24.1	22.8
$T_3 N_{60}$	16.3	15.6	5.00	2.73	54.6	54.6	16.7	16.7

8. Nodules number and nodules weight:

Results tabulated in Table 7 show that nitrogen application times high significantly affected nodules number in both seasons. The highest nodules number values of 80 and 84 per plant were obtained with T_3 treatment in the first and second seasons, respectively. On the other hand, the lowest nodules number values were obtained with T_1 treatment in both seasons.

Table 7: Effect of nitrogen fertilization times on soybean nodules number, nodules dry weight mg, residual available N and P in the soil.

N-application time	Nodules number		Nodules weight		Available P (ppm)		Available N (ppm)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
T_1	24 c	25 c	0.29 c	0.32 c	7.4	8.2 b	28 b	28
T_2	60 b	75 b	0.41 b	0.42 b	7.3	8.3 b	38 a	35
T_3	80 a	84 a	0.51 a	0.51 a	8.1	9.5 a	35 a	31
F-test	**	**	**	**	N.S	*	**	N.S
L.S.D.	6.4	4.6	0.07	0.08		0.71	2.44	

The nodules dry weight had the same trend of nodules number, where the highest value (0.51 mg) was obtained with T_3 treatment in both seasons. The variances between the treatments were high significant in both seasons.

Nitrogen levels had highly significant effect on nodules number and nodules dry weight (Table 8). The highest nodules number values of 86 and 97 were detected with N_{60} treatment in the first and second season, respectively. The highest nodules dry weight (60 and 69 mg per plant) were obtained with N_{60} treatment in both seasons. The lowest nodules number values were obtained with N_0 treatment, while the lowest nodules dry weight values were recorded with N_{20} treatment in both seasons.

Table 8: Effect of nitrogen fertilization levels on soybean nodules number, nodules dry weight mg, residual available N, residual available P in the soil.

Nitrogen levels	Nodules number		Nodules weight		Available P (ppm)		Available N (ppm)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
N_0	35	41	0.57	0.69	8.0	9.1	28.0	27.9
N_{20}	39	54	0.33	0.33	7.4	8.4	31.7	30.8
N_{40}	58	63	0.37	0.35	7.2	8.4	44.8	36.2
N_{60}	86	97	0.60	0.69	7.7	8.8	28.9	30.9
F-test	**	**	**	**	N.S	N.S	**	N.S
L.S.D. 0.05	5.2	2.48	0.04	0.03			2.11	

The interaction between nitrogen application times and levels high significantly affected nodules number and nodules dry weight (Table 9). The highest nodules number values of 107 and 135 were obtained with T_2 and N_{60}

treatment in the first and second seasons, respectively. The highest dry weight values of 1.22 and 1.20 (mg) were obtained with the check treatment. This may be due to nitrogen application could be affect nodules information and effective. These results are in agreement with those obtained by Eaglesham *et al.*, 1983 and Parsons *et al.*, 1993.

Table 9: Effect of the interaction between nitrogen fertilization times and levels on soybean nodules number, nodules dry weight mg, available P and available N in the soil.

Treatments	Nodules number		Nodules weight		Available P (ppm)		Available N (ppm)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
$T_1 N_0$	24 f	29 g	1.22 a	1.20 a	9.0 a	9.3 bc	25.2 ef	25.2 d
$T_1 N_{20}$	9 g	7 l	0.17 g	0.15 e	8.0 ab	8.3 cd	22.4 f	23.9 d
$T_1 N_{40}$	23 f	22 h	0.20 g	0.19 e	6.5 bc	8.0 cd	28.0 e	28.0 c
$T_1 N_{60}$	39 e	42 f	0.57 c	0.72 b	6.0 c	7.2 d	28.0 e	28.3 c
$T_2 N_0$	25 f	29 g	1.02 a	1.35 a	9.0 a	9.3 bc	25.2 ef	25.6 d
$T_2 N_{20}$	24 f	21 h	0.46 de	0.49 c	7.0 bc	8.3 cd	44.7 c	38.7 bc
$T_2 N_{40}$	53 d	58 e	0.39 ef	0.37 d	8.0 ab	9.5 bc	56.0 a	49.5 a
$T_2 N_{60}$	107 a	135 a	0.58 c	0.69 b	8.0 ab	7.9 cd	22.4 f	26.1 d
$T_3 N_0$	25 f	29 g	01.07 a	1.09 a	9.0 a	9.38 c	25.2 ef	26.4 d
$T_3 N_{20}$	85 c	96 d	0.36 f	0.37 d	7.3 bc	8.4 cd	28.0 e	29.9 c
$T_3 N_{40}$	97 b	108 c	0.53 cd	0.51 c	7.0 bc	7.7 d	50.3 b	41.4 b
$T_3 N_{60}$	101 a	113 b	0.66 b	0.67 b	9.0 a	11.2 a	36.4 d	38.8 bc
F-test	**	**	**	**	**	**	**	*
L.S.D. 0.05	9.08	4.2	0.076	0.05	1.46	1.44	3.6	4.8

9. Available residual nutrients:

Data presented in Table 7 show that nitrogen application times had no significant effect on available phosphorus in the first season. In the second season the effect was significant. The highest value of 9.5 ppm was obtained with T_3 treatment.

Available nitrogen was affected high significantly by nitrogen application times in the first season. The highest available nitrogen was detected with T_2 treatment. In the second season no significant effects were detected.

Data tabulated in Table 8 show that no significant effect of nitrogen levels on available phosphorus was observed in both seasons. Meanwhile, available-N was high significantly affected by N-levels in the first season.

The highest available-N value of 44.8 ppm was obtained with N_{40} treatment. No significant effects were detected in the second season. These results are in agreement with those obtained by Eaglesham *et al.* (1983), Keyser and Fudi Li, 1992 and Parsons *et al.*, 1993.

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تأثير مستويات السماد النيتروجينى ومواعيد إضافته على إنتاجية فول الصويا

رمضان إسماعيل كنانى* ، عاطف صبحى محمود السعدى* ، رجب حجازى عطيه*

معهد بحوث الأراضى والمياه والبيئة – مركز البحوث الزراعية – الجيزه – مصر

أجريت تجربتان حقليتان بمزرعة محطة البحوث الزراعية بسخا خلال الموسمين الصيفين ٢٠٠٢ ، ٢٠٠٣ لدراسة أثر مستويات السماد النيتروجينى ومواعيد إضافته على إنتاجية فول الصويا. حيث استخدم فول الصويا صنف جيزه ١١١ ، كما استخدم تصميم القطع المنشقة فى أربعة مكررات. شغلت القطع الرئيسية بثلاثة مواعيد إضافة هى:

١- إضافة السماد النيتروجينى مع الرية الأولى.

٢- إضافة السماد النيتروجينى مع الرية الثانية.

٣- إضافة السماد النيتروجينى مع الرية الثالثة.

كما شغلت القطع الشقية بأربعة مستويات من السماد النيتروجينى هى صفر ، ٢٠ ، ٤٠ ، ٦٠كجم نيتروجين للفدان. وكانت مساحة القطعة التجريبية ١٥م٢ وأجريت العمليات الزراعية الأخرى كما بالتوصيات.

وتتلخص النتائج المتحصل عليها فى الآتى:

كان لمواعيد إضافة السماد النيتروجينى تأثير عال المعنوية على محصول البذور ومحصول القش ومحصول الزيت ومحصول البروتين حيث أعطى ميعاد الإضافة الأول (إضافة النيتروجين مع الرية الأولى) أعلى محصول قش خلال الموسمين. بينما أعطى ميعاد الإضافة الثانى (إضافة النيتروجين مع الرية الثانية) أعلى محصول بذور (٦٩٩ ، ٦٦٥ كجم/فدان) وأعلى محصول زيت (٢٣١ ، ٢٨٧ كجم/فدان) وأعلى محصول بروتين (٣٥٦ ، ٣٤٦ كجم/فدان) فى الموسمين الأول والثانى على التوالى.

كما أدى إضافة النيتروجين مع الرية الثانية إلى زيادة كفاءة استخدام السماد. بينما أعطت إضافة النيتروجين مع الرية الثالثة أعلى عدد عقد بكتيرية على الجذور وأعلى قيم للوزن الجاف للعقد وأعلى نيتروجين وفوسفور ميسر متبقى فى الأرض.

كما كان لمستويات التسميد النيتروجينى تأثير عال المعنوية على القياسات المدروسة حيث أعطى المستوى ٦٠ وحدة نيتروجين للفدان أعلى محصول بذور وقش وزيت وبروتين. وعلى الجانب الآخر أدت زيادة مستويات التسميد النيتروجينى إلى نقص كفاءة استخدام السماد النتروجينى المضاف وأعطى المستوى ٦٠ وحدة نيتروجين للفدان أعلى قيم فى عدد العقد على الجذور والوزن الجاف للعقد.