EFFECT OF IRRIGATION AND FERTILIZATION ON LENTIL
II- YIELD AND YIELD COMPONENT

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ABSTRACT

Two field experiments were carried out at the Agricultural Research and Experimental Station, Faculty of Agriculture at Moshtohor, Kalubia, Egypt, during 1984/85 and 1985/86 seasons to study the effect of irrigation number and NP fertilizer treatments on lentil yield and its component. Each experiment included 24 treatments which were the combination of four irrigation treatments and six NP fertilizer treatments.

The results showed that, by increasing irrigation frequency up to three times significantly increased plant height, number of branches/plant, number of pods/plant, number of seeds/pod, number of seeds/plant, yields of seeds, straw, biological and protein/fad. in the two successive seasons. Harvest index was significantly increased with increasing irrigations number up to two times in both seasons. On the other hand, irrigation number had no effect on protein (%) and phosphorus content of seeds.

In the both seasons, plant height and number of branches per plant were significantly affected with fertilization. Increasing levels of N and P up to 15 kg N + 48 kg P_2O_5/fad. produced higher values of seed yield/fad. and P content in lentil seeds in both seasons, also harvest index and protein (%) in the first season only.

The effect of the interaction between number of irrigations and NP fertilizers was not significant in all studied characters.

INTRODUCTION

In Egypt, lentil (Lens esculenta, Moench) is the second important crop among five pulse crops after field bean (Vicia faba L.). The allotted area of this crop is about 20 thousand faddans in 1985/86 seasons. However, the total production is less than the demand of the local consumption.

Recently, efforts are exerted to the increase of lentil productivity by means of: **(a)** effecient use N and P fertilizers (Hassannein, 1981; Nema et al., 1984; Yadav et al., 1985 and Madkour, 1987). **(b)** determining the appropriate irrigation frequency (El-Warraky, 1978; El-Assily, 1980 and Katare et al., 1984).

In this study it was intended to investigate the effect of number of irrigation and fertilization with N and P on growth and yield of lentil.

MATERIALS AND METHODS

Materials and methods were previously described in the first paper of this series (Sary et al., 1989). The following data were recorded:

I- Lentil characters of harvesting:

1- Plant height in cm.; number of branches/plant, number of pods/plant, number of seeds/pod, number of seeds/plant and seed weight/plant in g. which were determined from the average of 10 plants sample taken at random, from each sub-plot.

2- Percentage of aborted seeds was determined by dividing the weight of abrotive seeds by the weight of sample and mutliplied by 100.

3- Weight of 1000-seed, was obtained from the averages of 5 samples taken at random of each subplot.

4- Seed yield and straw yield/fed. in kg., which were determined from the weight of seeds and weight of straw for sub-plot.

5- Harvest index, was calculated, using the formula given by Chondra and Lal (1976).

II- Seed cheimcal analysis:

1- Total nitrogen was determined by the microkjeldahl method (A.O.A.C., 1955). Protein % was calculated by multiply in the total nitrogen by 6.25 (Tripthi et al., 1971).

2- Phosphorus % was determined colorimetrically (John, 1970).

RESULTS AND DISCUSSION

I- Effect of Irrigation:

1- Plant height and number of branches/plant:

Results in Table (1) indicate clearly that, increasing irrigation up to three times during the growing season significantly increased the plant height as well as number of branches/plant. This result was true in both seasons. On the other hand, increasing irrigation number up to four times significantly decreased number of branches/plant in both seasons. These findings are in general agreement with those obtained by Ahmed (1975), on field bean, Hassannein (1981); Hussein et al., (1984) on lentil and Madkour (1987) on chick pea.

2- Number of pods, seeds/pod and seeds/plant:

In both seasons, number of pods/plant, number of seeds/pod and number of seeds/plant were increased by increasing number of irrigations up to three times. Any further irrigation significantly reduced number of previous characters (Table 2). These results are expected since such characters positively correlated with the number of branches/plant and agreed with those reported by El-Warraky (1978); Rizk (1979); Hassannein (1981) and Hussein et al., (1984).

3- Percentage of aborted seeds:

The aborated seeds % significantly decreased as the number of irrigations increased up to four irrigations in 1984/85 and 1985/86 seasons (Table 2). These results were expected since recieving one irrigation treatment after 30 days from sowing caused drought effect on lentil plants especially during the seed filling stage. These results were in agreement with those obtained by Hussein et al., (1984).

4- Weight of 1000-seed:

Weight of 1000-seed significantly increased with irrigation up to three irrigations in the both seasons (Table 2). Nevertheless, 1000-seed weight decreased significantly

Table (1): Effect of number of irrigations on growth characters of lentil.

Irrigation number	Plant height		No. of branches	
	cm	Rel.	/ plant	Rel.
		1. 1984/85 season		
One irrigation	36.98 a	100	4.86 a	100
Two irrigations	38.61 ab	104	6.07 b	125
Three irrigations	42.54 c	115	6.50 c	134
Four irrigations	40.49 bc	109	6.28 bc	129
		2. 1985/86 season		
One irrigation	38.26 a	100	5.10 a	100
Two irrigations	40.51 ab	106	6.23 b	122
Three irrigations	44.01 b	115	6.68 d	131
Four Irrigations	41.68 ab	109	6.46 c	127

Irrigation number	No. of pods/plant	No. of seeds/pod	No. of seeds/plant	Percentage of abortive seeds	Wt. of 1000-seed(g)	Wt. of seeds/plant(g.)
			1. 1984/85 season.			
One irrigation	51.77 a	1.21 a	63.10 a	3.23 d	22.35 a	1.16 a
Two irrigations	64.38 b	1.29 b	82.60 b	2.42 c	24.19 b	1.28 b
Three irrigations	77.48 d	1.41 c	108.20 d	1.95 b	25.63 c	1.37 c
Four irrigations	70.18 c	1.32 b	93.10 c	1.38 a	24.38 b	1.32 bc
			2. 1985/86 season.			
One irrigation	52.56 a	1.25 a	66.3 a	3.60 c	22.92 a	1.19 a
Two irrigations	65.11 b	1.33 b	87.0 b	2.59 b	25.09 b	1.35 b
Three irrigations	78.41 d	1.47 c	114.0 d	2.10 ab	26.66 c	1.39 b
Four irrigations	70.97 c	1.36 b	97.1 c	1.51 a	25.48 b	1.44 b

with increasing irrigations number up to four times. These results revealed that weight of 1000-seed inversely correlated with the percentage of abortive seeds. Similar conclusion was reported by Rizk (1979); Hassannein (1981) and Hussein et al., (1984).

5- Weight of seeds/plant:

Weight of seeds/plant significantly increased with increasing number of irrigations until three irrigations in the first season and until two irrigations in the second season (Table 2). This result might be attributed to the increase in number of pods/plant, number of seeds/plant and wiehgt of 1000-seed. These results were expected since increasing irrigation frequency might encourage the metabolites synthesis which in turn enhanced pod formation, seed setting and seed filling which might interpret the increase in weight of seeds/plant. These results agree with those reported by El-Warraky (1978); Rizk (1979) and Hussein et al., (1984).

6- Seed yield/fad.:

Data presented in Table (3) indicate clearly that the seed yield significantly incraesed with increasing number of irrigations till three times. These results are expected since recieving three irrigations significantly increased plant height, number of branches/plant, number of pods/plant, number of seeds/pod, number of seeds/plant weight of 1000-seed and weight of seeds/plant and decreased significantly percentage of aborted seeds in the both season. Similar results were obtained by Ahmed (1975); El-Warraky (1978); El-Assily (1980) and Katare et al., (1984).

7- Straw yield/fad.:

Irrigation frequency had significant effect on straw yield in the two successive seasons (Table 3). Increasing irrigation number up to three times significantly increased straw yield/fad. compared with one and two irrigations. This superiority in straw yield could be attributed mainly to the increase in plant height as well as number of branches/plant. These results are in harmony with those obtained by Ahmed (1975); in field bean; El-Warraky (1978); Rizk (1979) and Hussein et al., (1984) in lentil.

8- Biological yield/fad.:

The obtained results in the two growing seasons, indicate that increasing irrigations number up to three times significantly increased the biological yield/fad. (Table 3). The effect of irrigation frequency might by attributed to the increase in the yield of seeds as well as straw yield/fad.

Table (3) : Effect of number of irrigations on yields of seed, protein and biological of lentil.

Irrigation number	Seed yield		Protein yield		Straw yield	Biological yield	H.I.
	Kg/fad.	Rel.	Kg/fad.	Rel.	Kg/fad.	Kg/fad.	
			1. 1984/85 season.				
One irrigation	584.0 a	100	158.9 a	100	2300 a	2884.0 a	20.37 a
Two irrigations	665.6 b	114	188.2 b	118	2480 ab	3145.6 ab	21.68 b
Three irrigations	780.8 c	134	214.5 c	135	2670 b	3450.8 b	22.45 b
Four irrigations	707.2 b	121	193.1 b	122	2550 b	3257.2 ab	21.97 b
			2. 1985/86 season.				
One irrigation	633.6 a	100	164.5 a	100	2410 a	3043.6 a	21.15 a
Two irrigations	723.2 a	114	196.1 b	119	2650 b	3373.2 b	22.50 b
Three irrigations	872.0 b	138	245.6 c	149	2870 c	3742.0 c	23.32 b
Four irrigations	744.0 a	117	202.1 b	123	2730 bc	3474.0 bc	22.77 b

9- Harvest index:

Results in Table (3) show that harvest index (H.I.) was significantly increased by increasing irrigation number up to two times. This was true in the both seasons. These results could be explained by the increase in seed yield of lentil since irrigation frequency was more proportional to the increase in straw yield. In this respect, Hussein et al. (1984), reported that the differences in harvest index due to irrigation frequency were not significant. Whereas, Ahmed (1975), on field bean, found that harvest index decreased by increasing irrigation number.

10- Chemical content of seeds:

a- Protein content:

Data presented in Table (4) show clearly that the number of irrigations had no significant effect on protein percentage of lentil seeds. This result was true in the two successive seasons. These results were in agreement with those obtained by Gibali et al. (1968) and Ahmed (1975), with field bean and El-Warraky (1978), in lentil.

b- Protein yield/fad.:

The protein yield/fad. significantly increased by increasing irrigation number up to three irrigations in the two successive seasons (Table 4). The increase in N absorption under adequte soil water might owe much to increase in N content of seeds. Similar results were obtained by Gibali et al. (1968), in field bean and Hussein et al. (1984) in lentil.

c- Phosphorus content:

Results in Table (4) indicate clearly that seed phosphorus content was not significantly affected with the number of irrigations in the growing seasons. These results are inagreement with those of Hussein et al., (1984).

Table (4): Effect of number of irrigations on the chemical content of lentil.

Irrigation number	1984/85 season		1985/86 season	
	Crude protein %	P %	Crude protein %	P %
One irrigation	26.84 a	0.632 a	27.00 a	0.647 a
Two irrigation	26.97 a	0.655 a	27.13 a	0.665 a
Three irrigation	26.99 a	0.671 a	27.29 a	0.684 a
Four irrigation	27.07 a	0.705 a	27.35 a	0.723 a

II- Effect of fertilizer:

1- Plant height and number of branches/plant:

Data in Table (5) show that application of N and P significantly increased the height of lentil and number of branches/plant. These results might be attributed to the good effect of N on the vegetative growth and the effect of P on the growth of roots of lentil plants. Similar results were obtained by Singh, (1971); Rizk, (1979) and Hassannein (1981).

Table (5): Effect of fertilizer on growth characters of lentil.

Fertilizer treatments	Plant height		No. of branches	
	cm	Resl.	Plant	Rel
		1984/85 season		
N_0P_0 (control	35.62 a	100	5.24 a	100
N_1P_0	40.37 cd	113	6.09 b-d	116
N_0P_1	37.89 ab	106	5.75 b	110
N_1P_1	41.81 de	117	6.26 cd	119
N_0P_2	39.16 bc	110	5.86 bc	112
N_1P_2	43.09 e	121	6.37 d	121
		1985/86 season		
N_0P_0 (control	38.27 a	100	5.54 a	100
N_1P_0	41.66 a-c	109	6.27 bc	113
N_0P_1	39.93 ab	104	5.91 ab	107
N_1P_1	42.74 bc	112	6.39 bc	115
N_0P_2	40.66 a-c	106	6.12 bc	110
N_1P_2	44.00 c	115	6.50 c	117

2- Number of pods/plant:

Application of 15 kg N + 24 kg P_2O_5/fad. (N_1P_1) significantly increased the number of pods/plant as compared with N_0P_0, N_1P_0, N_0P_1 and N_0P_2 in the first season and N_0P_1 and N_0P_2 in the second season. The application of a higher level of fertilizer (N_1P_2) failed to show further significant increase (Table 6). This result was true in both seasons. This result might be attributed to the effect of N and P in increasing the vegetative growth and meristeimatic activity of lentil plants. These findings are in general, agreement with those obtained by Rizk (1979); Hassanein (1981) and Madkour (1987).

3- Number of seeds/pod and number of seeds/plant:

The obtained results in Table (6) show that the maximum number of seeds/pod and per plant were obtained by the application of 15 kg N + 48 kg P_2O_5/fad. (N_1P_2). This result was true in both seaosn. This result was expected since P-fertilizer significantly increased percentage of filled pods as well as number of pods/plant. These results are in a good line with those of Mostafa (1973), on broad bean and Hassannein (1981).

4- Percentage of aborted seeds:

In 1984/85 season, percentage of aborted seeds was significantly increased by increasing level of fertilizers up to 15 kg N + 48 kg P_2O_5/fad. (N_1P_2). The differences between N_1P_1 and N_1P_2 was not significant (Table 6). A similar trend without significant differences was observedin 1985/86 season. These results disagreed with those obtained by El-Warraky (1978).

5- Weight of 1000-seed:

The weight of 1000-seed significantly increased with increasing level of fertilizers up to 15 kg N + 24 kg P_2O_5/fad. (N_1P_1) in the first season and up to 15 kg N + 48 kg P_2O_5/fad. (N_1P_2) in the second season (Table 6). These results are expected since N and P fertilizers significantly increased percentage of filled pods (Madkour, 1987). Similar results were also obtained by Rizk (1979).

6- Seed weight/plant:

The weight of seeds/plant significantly increased as the levels of fertiliziers increased up to 15 kg N + 24 kg P_2O_5/fad. (N_1P_1) in the first season. Differences between N_1P_1 and N_1P_2 failed to reach the level of significance at 5%. In the second season, similar results were obtained, where the maximum weight of seeds/plant was obtained by the application of 15 kg N + 48 kg P_2O_5/fad. (N_1P_2). All differences in seeds weight/plant between in N_1P_0, N_1P_1 and N_1P_2 were not significant.

7- Seed yield/fad.:

Data presented in Table (7) indicate clearly that N and P had significant effect in increasing the seed yield of lentil. Maximum seed yield was obtained by applying 15 kg N + 48 kg P_2O_5/fad. (N_1P_2) in the both seasons. These results were expected since NP fertilizers significantly increased number of branches/plant, number of pods/plant, number of seeds/pod, number of seeds/plant, weight of 1000-seed and seed weight/plant. These results agreed with several results obtained by Singh (1971); Sharar *et al.*,

Table (6): Effect of fertilizer on yield components of lentil.

Fertilizer treatment	No. of pods/plant	No. of seeds/pod	No. of seeds/plant	Percentage of abortive seeds	Wt. 1000-seed(g.)	Wt. seeds/plant(g.)
			1. 1984/85 season.			
N_oP_o(control)	56.76 a	1.13 a	64.88 a	1.57 a	21.92 a	1.09 a
N_1P_o	68.27 c	1.35 cd	90.98 d	2.36 cd	24.80 cd	1.32 c
N_oP_1	62.64 b	1.24 b	78.58 b	1.92 ab	23.38 b	1.17 b
N_1P_1	70.71 d	1.40 d	97.84 e	2.61 cd	25.25 d	1.40 d
N_oP_2	64.69 b	1.30 bc	84.96 c	2.22 bc	24.04 bc	1.23 b
N_1P_2	72.37 d	1.43 d	103.31 F	2.79 d	25.73 d	1.46 d
			2. 1985/86 season.			
N_oP_o(control)	57.55 a	1.21 a	71.01 a	1.99 a	22.84 a	1.15 a
N_1P_o	69.07 cd	1.39 bc	95.87 d	2.50 a	25.62 bc	1.39 cd
N_oP_1	63.66 b	1.29 ab	82.69 b	2.20 a	24.44 ab	1.23 ab
N_1P_1	71.29 d	1.42 c	101.57 e	2.73 a	25.99 bc	1.45 cd
N_oP_2	65.98 bc	1.35 bc	89.51 c	2.40 a	24.89 bc	1.33 bc
N_1P_2	73.17 d	1.45 c	106.08 e	2.89 a	26.46 c	1.50 d

Table (7) : Effect of fertilizer on yields of seed, protein and biological in lentil.

Fertilizer treatment	Seed yield Kg/fad.	Rel.	Protein yield Kg/fad.	Rel.	Straw yield Kg/fad.	Biological yield Kg/fad.	H.I.
			1. 1984.85 season.				
N_oP_o(control)	550 a	100	146.74 a	100	2360 a	2910 a	18.77 a
N_1P_o	712 d	129	191.70 c	131	2520 a	3232 b-d	22.26 d
N_oP_1	613 b	111	164.74 b	112	2420 a	3033 ab	20.14 b
N_1P_1	762 e	138	210.51 d	143	2570 a	3332 cd	23.20 e
N_oP_2	666 c	121	183.78 c	125	2490 a	3156 a-c	21.17 c
N_1P_2	805 F	146	224.25 e	153	2650 a	3455 d	24.18 F
			2. 1985/86 season.				
N_oP_o(control)	618 a	100	163.10 a	100	2520 a	3138 a	19.49 a
N_1P_o	778 cd	126	210.50 c	129	2700 a	3478 b-d	23.08 d
N_oP_1	672 ab	109	181.50 ab	111	2560 a	3232 ab	20.95 b
N_1P_1	814 d	132	221.80 cd	136	2750 a	3564 b-d	24.10 e
N_oP_2	738 bc	119	198.00 bc	121	2640 a	3378 a-c	21.99 c
N_1P_2	842 d	136	237.30 d	145	2830 a	3672 d	25.00 e

(1976); Prasad (1978); Rizk (1979); Eweida et al., (1980); Ali et al., (1981); Hassannein (1981); Verma & Kalra (1981 & 1983); Nema et al., (1984); Yadav et al., (1985) and Madkour (1987).

8- Straw yield/fad.:

Results in Table (7) indicate clearly that straw yield per faddan was not significantly affected by increasing nitrogen and phosphorus levels. These results were true in the two successive seasons. Similar results were obtained by Badaway (1976) and El-Warraky (1978).

9- Biological yield/fad.:

The effect of fertilization on biological yield/fad. showed similar trend to the seed yield/fad. in the two sucessive seasons (Table 7). These results are in agreement with those obtained by Madkour (1987).

10- Harvest index:

Data presented in Table (7) show that harvest index significantly increased as the levels of fertilizers increased up to 15 kg N + 48 kg P_2O_5/fad. (N_1P_2) in the first season, and up to 15 kg N + 24 P_2O_5/fad. (N_1P_1) in the second season. Similar results were obtained by Madkour (1987).

11- Chemical contnet of seeds:

a- Protein content:

Application of 15 kg N + 48 kg P_2O_5/fad. (N_1P_2) significantly increased N% of lentil seeds only in the first season. The result agrees with those obtained by Singh (1971); Eweida (1980) and Hussein et al., (1984).

Table (8): Effect of fertilizer on the chemical content of lentil seeds.

Fertilizer treatments	1984/85 season		1985/86 season	
	Crude protein %	P %	Crude protein %	P %
N_0P_0 (control)	26.37 a	0.602 a	26.49 a	0.619 a
N_1P_0	27.20 ab	0.674 cd	27.48 a	0.688 b-d
N_0P_1	26.49 a	0.640 b	26.79 a	0.656 ab
N_1P_1	27.31 ab	0.697 de	27.55 a	0.710 cd
N_0P_2	26.85 ab	0.663 bc	27.22 a	0.680 bc
N_1P_2	27.58 b	0.718 e	27.60 a	0.727 d

b- Protein yield/fad.:

Application of N and P significantly increased the protein yield of lentil in both seasons. This increase was more evident at the highest level. These results were expected since increasing levels of NP increased seed yield in both seasons, as well as protein content of lentil seeds in the first season only. Such result reveals the important role of fertilizers on protein content in legumes and agrees with those obtained by Hussein et al., (1984).

c- Phosphorus content:

Data in Table (8) indicate that increasing rates of N and P significantly increased the content of P. The maximum P-content of lentil seeds was obtained by the application of 15 kg N + 48 kg P_2O_5/fad. (N_1P_2) in both seasons. This increase proved the importance of fertilization in increasing absorption of other nutrients and increasing the mineral contents of lentil seeds.

III- Effect of the interaction:

The effect of the interaction between number of irrigations and NP fertilizers on the studied characters was not significant in the two successive seasons on all characters.

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