

## RESPONSE OF FABA BEAN TO NITROGEN FERTILIZER LEVELS AND TIMES OF APPLICATION

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### ABSTRACT

Two field experiments were carried out on faba bean (*Vicia faba* L.) Giza 184 at Sakha Agricultural Research Station Farm, Kafr El-Sheikh Governorate, during the two successive winter seasons of 2003/2004 and 2004/2005 to study the effect of application times and levels of nitrogen fertilizer (ammonium nitrate) on faba bean yield and its components. Split plot design was used. The main plots were assigned to three nitrogen application time: 1-addition at sowing ( $T_1$ ), 2- addition at the first irrigation ( $T_2$ ), 3- addition at the second irrigation ( $T_3$ ). The sub plots were allotted to four nitrogen levels as follows  $0(N_0)$ ,  $15(N_{15})$ ,  $30(N_{30})$  and  $45(N_{45})$  kg N  $fed^{-1}$ . The efficiency of nitrogen application times on straw and biological yield of faba bean in both seasons were highly significant. The first treatment ( $T_1$ ) gave the highest seed yields ( $1541$  and  $1624$  kg  $fed^{-1}$ ) and straw yields ( $2763$  and  $2741$  kg  $fed^{-1}$ ) in the first and second seasons, respectively. While, the third treatment ( $T_3$ ) gave the lowest seed and straw yields in both seasons.

Also, the efficiency of N-levels on seed yield, nitrogen, protein and phosphorus contents as well as 100 seeds weight were highly significant in both seasons. The interaction effects between nitrogen application times and nitrogen levels were obvious on the seed and straw yield, also on the protein, nitrogen and phosphorus contents of seeds and straw phosphorus content in both seasons. The contents of nitrogen and protein in straw yield in both seasons were significantly increased. The available soil nitrogen increased by increasing the levels of applied N-fertilizer in both seasons. Also, times of nitrogen application were efficacious on the amount of available soil nitrogen after harvest as follows  $T_3 > T_2 > T_1$ . The highest estimated income values (LE) were obtained by the treatment of 30 kg N at sowing in both seasons.

### INTRODUCTION

Faba bean is the most important crop among the major grain legumes cultivated in Egypt. It make a good contribution of Egyptian diet as a cheap source of the calories, protein, carbohydrate, fibre and low fat. There is urgent need to increase the vertical production of faba beans to face the increasing demand of the people. Using different agricultural management as nitrogen rates and application times are important operation for the production.

Wide variation of protein content (20-41%) has been reported (Chaven *et al.*, 1989). It consume for human food and livestock feed. Protein concentration is influence by both genetic and environmental factors (Bond *et al.*, 1985).

Several workers investigated the effect of N-fertilizer levels on growth and yield of faba bean. Application of nitrogen at  $10-20$  kg  $fed^{-1}$  as starter doses increased the activity of nitrogen fixation and improved faba bean productivity. (Kandil, 1985, Metwally, 1997 and Said, 1998). Soghin (1998) pointed that, low rats of nitrogen fertilizer stimulated the activity of

symbiotic N<sub>2</sub>-fixing bacteria, but high rates were make inhibition. Abd El-Aal (1990) found that increasing nitrogen levels up to 60 kg fed<sup>-1</sup> increased biological yield per plant and seed yield fed<sup>-1</sup>. While, Metwally (1997) revealed that, 100-seed weight as well as seed and straw yields fed<sup>-1</sup> were markedly increased with raising nitrogen rates up to 45 kg N fed<sup>-1</sup>. On soybean Knany *et al.* (2004) reported that nitrogen application time significantly affected soybean yields. They found that application of N fertilizer with the second irrigation had the highest yield.

The aims of the present study were to evaluate the effects of mineral nitrogen fertilizer levels and times of application on faba bean seeds, straw and biological yields, as well as, nitrogen, phosphorus, and protein contents. Also available nitrogen and phosphorus in soil at harvest, were estimated.

## MATERIALS AND METHODS

Two field experiments were carried out at Sakha Agricultural Research Station Farm, Kafr El-Sheikh Governorate during the agricultural winter seasons of 2003/2004 and 2004/2005 to investigate the effects of nitrogen application times and nitrogen fertilizer levels on faba bean productivity. Using faba bean (*Vicia faba* L.) variety Giza 184. The recommended seeds rate (60 kg fed<sup>-1</sup>) was planted, 1-2 seeds in the hill, 20 cm between the hills on one side of the ridge, and 60 cm between the ridges. The sowing date was November, 19<sup>th</sup> and 21<sup>st</sup> in the first and second season, respectively. Split plot design was used in four replicates. The main plots were randomly assigned to three application times of nitrogen fertilization of 1- at the sowing (T<sub>1</sub>), 2- at the first irrigation (T<sub>2</sub>), and 3-at the second irrigation (T<sub>3</sub>). The sub plots were randomly assigned to four nitrogen levels as follows: 0 (N<sub>0</sub>), 15 (N<sub>15</sub>), 30 (N<sub>30</sub>) and 45 (N<sub>45</sub>) kg fed.<sup>-1</sup> as NH<sub>4</sub>NO<sub>3</sub> 33%. The plot area was 9.6 m<sup>2</sup>.

The other recommended cultural practices were normally followed.

Some properties of the experimental soils were reported in Table 1 as follows:

Table 1: Some properties of the experimental soils

	Sand %	Silt %	Clay %	Texture	EC <sup>s</sup> dS m <sup>-1</sup>	pH <sup>#</sup>	Available nutrient mg kg <sup>-1</sup>		
							N	P	K
1 <sup>st</sup> season	20.83	21.60	57.57	Clayey	2.8	8.0	22.4	8.0	280
2 <sup>nd</sup> season	20.60	21.10	58.30	Clayey	3.0	8.1	21.0	8.5	300

<sup>s</sup> Soil paste extract

<sup>#</sup> 1:2.5 soil water suspension

N, P and K were determined according to Jackson (1958)

At faba bean harvest, the seed and straw yields were weighted, seed and straw samples were collected, oven dried at 65°C, fine ground and wet digested according to Piper (1947). Total N was determined by Kjeldahl method, total P was colourimetrically determined in the digestion according to Jackson (1958). Nitrogen and phosphorus content were calculated by multiplying N% and P% by yield kg fed<sup>-1</sup>. Protein (kg fed.<sup>-1</sup>) were calculated

by multiplying N content (kg fed.<sup>-1</sup>) by 6.25. At harvest, soil samples (0-30 cm) were collected and residual available N and P were determined according to the method described by Jackson (1958). Nitrogen use efficiency (NUE) was calculated by the following equation:

$$\text{NUE} = \frac{\text{Seed yield/treatment} - \text{Seed yield/control}}{\text{Applied N kg fed}^{-1}}$$

The obtained data were statistically analyzed according to Gomez and Gomez (1984). The less significant differences were determined between the measuring parameters means using MSTATC computer program.

The income from faba bean crop under each treatment was estimated by using the cost of the crop yield minus the cost of the used fertilizer in each treatment.

## RESULTS AND DISCUSSION

Data presented in Table 2 show that the faba bean seed yield was affected by N-application times. Addition of the nitrogen fertilizer at sowing time T<sub>1</sub> had the highest amount of seeds (1541 and 1624 kg fed<sup>-1</sup>) in the first and second seasons, respectively. The lowest values of seed yields (1416 and 1496 kg fed<sup>-1</sup>) were recorded under application of nitrogen fertilizer at the second irrigation. The differences in the seed yield between the nitrogen application times treatments were not significant. On the contrary faba bean straw yield high significantly affected by the nitrogen application times. The addition of nitrogen fertilizer at sowing had the highest straw yields (2763 and 2741 kg fed<sup>-1</sup>) in the first and second seasons, respectively. The lowest straw yield was obtained due to the application of nitrogen fertilizer at the second irrigation in both seasons. Nitrogen application times significantly affected the biological yield of faba bean in the first season and highly significantly in the second season. The highest biological yields of 4137 and 4446 were obtained with T<sub>1</sub> treatment. On the other hand, the lowest biological yields of 3599 and 3752 kg fed<sup>-1</sup> were recorded with T<sub>3</sub> treatment in the first and second seasons, respectively. Data shows that no significant effects of nitrogen application times on faba bean 100 seeds weight were observed. The increases in faba bean seed, straw and biological yields due to the T<sub>1</sub> treatment rather than the two other treatments could be attributed to the presence of the more available nitrogen which produced more healthy plants and enhanced nodulation which increased N<sub>2</sub>-fixation along plant growth period. On the other hand, the latter application of nitrogen after nodulation may negatively affect N<sub>2</sub>-fixation. These results could be enhanced by those obtained by Metwally (1997) and Said (1998) who found that application of nitrogen at 10-20 kg fed<sup>-1</sup> as starter dose increased the activity of nitrogen fixation and improved faba bean productivity.

**Table 2: Effect of nitrogen application times on faba bean seed, straw, biological yields and 100 seeds weight in both seasons.**

Variables	Seed yield (kg fed. <sup>-1</sup> )		Straw yield (kg fed. <sup>-1</sup> )		Biological yield (kg fed. <sup>-1</sup> )		100-seeds weight (g)	
	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>
T <sub>1</sub>	1541	1624	2763	2741	4137	4446	72.55	72.83
T <sub>2</sub>	1473	1557	2321	2398	3799	3962	72.48	72.80
T <sub>3</sub>	1416	1496	2102	2269	3599	3752	71.97	72.68
F-test	N.S	N.S	**	**	*	**	N.S	N.S
L.S.D. 0.05			441.4	282.8	497.9	198.6		

T<sub>1</sub> = Nitrogen was applied at the sowing, T<sub>2</sub> = Nitrogen was applied at the first irrigation  
 T<sub>3</sub> = Nitrogen was applied at the second irrigation

Data presented in Table 3 show that nitrogen levels have a high efficiency on the faba bean seed yield in both studied seasons. The highest seed yield were obtained with application of 30 kg N fed.<sup>-1</sup> (1635 and 1704 kg fed.<sup>-1</sup>) in the first and second seasons, respectively. The lowest seed yields (1277 and 1380 kg fed.<sup>-1</sup>) were obtained in the first and second season, respectively under N<sub>0</sub> treatment.

Also, the biological yield in the second season was significantly affected by the applied N-levels. The highest value (4212 kg fed.<sup>-1</sup>) was obtained under application of 45 kg N fed.<sup>-1</sup>, while the lowest value (3836 kg fed.<sup>-1</sup>) was observed with N<sub>0</sub> treatment. The biological yield was insignificantly affected during the first season.

Hundred seed weight highly significantly affected by nitrogen application levels in both seasons. The highest 100 seeds weight values (73.62 and 73.97 g) were obtained with application of 30 kg N fed.<sup>-1</sup> (N<sub>30</sub>) in the first and second seasons, respectively. On the other hand the lowest values (69.8 and 70.28 g) were observed with N<sub>0</sub> treatment. Nitrogen use efficiency is a parameter show the amount of faba bean seed (kg) which increased from using 1 kg N. Results of N-use efficiency showed that the values decreased with increasing the applied nitrogen. The previous data of seed, straw and biological yield may be due to increasing the applied-N up to 30 kg fed.<sup>-1</sup> enhanced nodulation and produced healthy plant, and increasing nitrogen application rather than 45 kg fed.<sup>-1</sup> may be inhibited Rhizobium activity. These results could be enhanced by the obtained by Saghin (1998) who pointed that low rates of nitrogen fertilizer stimulated the activity of symbiotic N<sub>2</sub>-fixing, but high rates were make inhibition.

**Table 3: Effect of nitrogen application levels on faba bean seeds, straw, biological yields, 100 seeds weight and nitrogen use efficiency in both seasons.**

Variable	Seed yield (kg fed. <sup>-1</sup> )		Straw yield (kg fed. <sup>-1</sup> )		Biologically (kg fed. <sup>-1</sup> )		100-seed weight (g)		N use efficiency	
	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>
N <sub>0</sub>	1277	1380	2285	2460	3677	3836	69.80	70.28	-	-
N <sub>15</sub>	1504	1595	2371	2430	3875	4024	72.86	72.98	15.13	14.33
N <sub>30</sub>	1635	1704	2351	2437	3986	4141	73.62	73.97	11.93	10.8
N <sub>45</sub>	1490	1558	2574	2550	3842	4212	73.05	73.94	4.7	3.95
F-test	**	**	N.S	N.S	N.S	**	**	**		
L.S.D. 0.05	100	85.92				290.4	2.71	1.88		

N<sub>0</sub> = Zero nitrogen N<sub>15</sub> = 15 kg N fed.<sup>-1</sup> N<sub>30</sub> = 30 kg N fed.<sup>-1</sup> N<sub>45</sub> = 45 kg N fed.<sup>-1</sup>

Data presented in Table 4 show that the interaction between nitrogen levels and their application times high significantly affected faba bean seed yield in both seasons. The highest seeds yield values (1922 and 1983 kg fed<sup>-1</sup>) were obtained with application of 30 kg N fed<sup>-1</sup> at sowing. While the highest faba bean straw yield (3316 and 3042 kg fed<sup>-1</sup>) was detected in the first and second seasons under N<sub>45</sub> treatment, respectively. Regarding, the biological yield the interaction between nitrogen levels and nitrogen application times was non significant in the first season and highly significant in the second season. The highest biological yield values (4710 and 4889 kg fed<sup>-1</sup>) were recorded under T<sub>1</sub>N<sub>30</sub> treatment in the first and second seasons, respectively. Also, the interaction between nitrogen levels and their application times has significant effect on the 100 seeds weight in both seasons. The highest values (74.3 and 74.5 g) were obtained under application of 30 kg N fed<sup>-1</sup> at the first irrigation in the first and second season, respectively. The data in Table 4 clear that , when the nitrogen fertilizer was applied early (T<sub>1</sub>) the response of faba bean was up to 30 kg N fed<sup>-1</sup>. With second application time T<sub>2</sub> the response was up to 45 kg N fed<sup>-1</sup>. While with the late application time T<sub>3</sub> the response was up to 15 kg N fed<sup>-1</sup>. This may be due to early application enhance the nodulation process which led to presence of self nutrition by symbiotic relationship, increasing N level rather than 30 kg inhibited N fixation. In the late application the plants were stunted and lose a period from the plant stages.

**Table 4: Effect of the interaction between nitrogen levels and their application times on faba bean seeds, straw and biological yields in both tested seasons.**

Variables	Seed yield (kg fed. <sup>-1</sup> )		Straw yield (kg fed. <sup>-1</sup> )		Biologically (kg fed. <sup>-1</sup> )		100-seeds (g)	
	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>
T <sub>1</sub> N <sub>0</sub>	1277	1380	2285	2460	3674	3827	72.30	72.00
T <sub>1</sub> N <sub>15</sub>	1531	1642	2552	2617	4083	4258	71.66	71.83
T <sub>1</sub> N <sub>30</sub>	1922	1983	2788	2846	4710	4889	72.62	73.00
T <sub>1</sub> N <sub>45</sub>	1432	1493	3316	3042	4082	4869	73.62	74.50
T <sub>2</sub> N <sub>0</sub>	1277	1380	2285	2460	3684	3840	67.41	68.67
T <sub>2</sub> N <sub>15</sub>	1441	1511	2270	2334	3711	3844	74.21	74.27
T <sub>2</sub> N <sub>30</sub>	1532	1615	2325	2411	3857	4026	74.30	74.50
T <sub>2</sub> N <sub>45</sub>	1645	1744	2298	2395	3943	4139	74.00	74.00
T <sub>3</sub> N <sub>0</sub>	1277	1380	2285	2460	3674	3840	69.68	70.17
T <sub>3</sub> N <sub>15</sub>	1540	1632	2290	2339	3830	3970	72.71	72.83
T <sub>3</sub> N <sub>30</sub>	1452	1516	1939	2053	3392	3569	73.95	74.40
T <sub>3</sub> N <sub>45</sub>	1392	1436	2108	2212	3500	3628	71.53	73.33
F-test	**	**	**	**	N.S	**	*	*
L.S.D. 0.05	133.2	114.4	538.9	448		386.7	3.61	2.51

The presented data in Table 5 show that no significant effects for nitrogen application times on nitrogen, protein and phosphorus contents of the faba bean seeds in both seasons. In faba bean straw nitrogen application times have a high significant effect on nitrogen and protein contents in both

seasons, while no significant effect was detected on phosphorus content. The highest N-content of the straw 20.6 and 20.23 kg fed.<sup>-1</sup>) was obtained with T<sub>1</sub> treatment in the first and the second seasons, respectively. On the other hand, the lowest values of 15.03 and 15.83 were observed with T<sub>3</sub> treatment (application of the nitrogen fertilizer with the second irrigation). Protein content had the same trend of nitrogen content. This may be due to application of the nitrogen fertilizer with the sowing produced healthy plants and good nodulation which affect nitrogen content and protein content of the straw. These results could be enhanced by those obtained by Knany *et al.* (2004) who reported that nitrogen application times high significantly affect protein yield, the highest values were with T<sub>2</sub> treatment application of N fertilizer at the second irrigation.

**Table 5: Effect of the nitrogen application times on N-content, protein content and phosphorus content (kg fed<sup>-1</sup>) of faba bean seeds and straw in both seasons.**

Variables	Seeds (kg fed <sup>-1</sup> )						Straw (kg fed <sup>-1</sup> )					
	N content		Protein content		P content		N content		Protein content		P content	
	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>
T <sub>1</sub>	50.47	53.43	315.46	333.89	3.67	4.01	20.60	20.23	128.77	126.46	0.33	0.34
T <sub>2</sub>	47.87	50.85	299.20	317.85	3.57	3.91	17.23	17.31	107.6	108.21	0.32	0.37
T <sub>3</sub>	45.51	47.58	284.42	297.4	4.19	4.40	15.03	15.83	93.94	98.92	0.37	0.37
F-test	N.S	N.S	N.S	N.S	N.S	N.S	**	**	**	**	N.S	N.S
L.S.D. 0.05							2.63	2.67	16.43	16.68		

Data of Table 6 show that, nitrogen levels high significantly affected nitrogen content of faba bean seeds in both seasons. The highest N-content values of 54.01 and 56.85 kg fed<sup>-1</sup> were obtained with N<sub>30</sub> treatment in the first and second season, respectively. Because protein content equal nitrogen content multiplying by 6.25 protein content had the same trend of nitrogen content in both seasons. The highest values of P content (4.35 and 4.61 kg fed<sup>-1</sup>) were obtained with N<sub>30</sub> treatment in the first and second season, respectively. On the contrary no significant effects were detected on N-content and protein content in the straw yield in both seasons. Phosphorus content in the straw yield had highly significant differences in the first season, but in the second season no significant differences were detected. These may be due to the seeds are the storage part of faba bean which affected by the nutritional status of the plant so that contents of protein, nitrogen and phosphorus were increased with the treatments which causes high yield. Similar findings were recorded by Bond *et al.* (1985).

Data presented in Table 7 show that, the interaction between nitrogen levels and nitrogen application times high significantly affected nitrogen content, protein content and phosphorus content in faba bean seeds in both seasons except P-content in the second season was significant only. The highest N-content values of 52.90 and 65.87 kg fed<sup>-1</sup> and the highest protein content values of 390 and 411.69 kg fed<sup>-1</sup> were observed with 30 kg N fed<sup>-1</sup> at sowing (T<sub>1</sub>N<sub>30</sub>) treatment in the first and second season, respectively. While the

highest P-content values of 5.59 and 5.31 kg fed<sup>-1</sup> were obtained with 30 kg N fed<sup>-1</sup> with the second irrigation (T<sub>3</sub>N<sub>30</sub>) treatment.

**Table 6: Effect of nitrogen application levels nitrogen, protein and P-contents (kg fed<sup>-1</sup>) of seeds and straw of faba bean in both seasons.**

Variables	Seeds (kg fed <sup>-1</sup> )						Straw (kg fed <sup>-1</sup> )					
	N content		Protein content		P content		N content		Protein content		P content	
Treatments	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>
N <sub>0</sub>	41.01	44.47	256.33	277.92	3.19	3.46	16.62	17.22	103.91	107.63	0.36	0.38
N <sub>15</sub>	49.25	52.40	307.83	327.50	4.18	4.57	18.47	18.31	115.43	114.43	0.29	0.33
N <sub>30</sub>	54.01	56.85	337.58	355.29	4.35	4.61	16.59	17.8	103.69	106.74	0.35	0.37
N <sub>45</sub>	47.53	48.78	297.02	304.81	3.52	3.78	18.79	18.56	117.47	115.99	0.36	0.34
F-test	**	**	**	**	**	**	N.S	N.S	N.S	N.S	**	N.S
L.S.D. 0.05	5.76	4.05	36	25.26	0.72	0.66					0.05	

**Table 7: Effect of the interactions between the nitrogen levels and their application times on N, protein and P-contents in seed and straw of faba bean in both seasons.**

Variables	Seeds (kg fed <sup>-1</sup> )						Straw (kg fed <sup>-1</sup> )					
	N content		Protein content		P content		N content		Protein content		P content	
Treatments	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>
T <sub>1</sub> N <sub>0</sub>	41.5	45.40	259.50	283.75	3.16	3.45	16.62	17.22	103.88	107.63	0.17	0.28
T <sub>1</sub> N <sub>15</sub>	50.89	53.90	318.08	336.85	4.17	4.59	20.84	20.16	130.25	125.98	0.18	0.24
T <sub>1</sub> N <sub>30</sub>	52.90	54.87	390.00	411.69	4.10	4.71	19.47	19.96	121.71	124.37	0.50	0.48
T <sub>1</sub> N <sub>45</sub>	47.10	48.56	294.25	303.27	3.24	3.28	25.48	23.60	159.25	147.48	0.46	0.34
T <sub>2</sub> N <sub>0</sub>	41.00	44.00	256.25	275.00	3.16	3.45	16.62	17.22	103.88	107.63	0.35	0.42
T <sub>2</sub> N <sub>15</sub>	46.82	49.68	292.60	310.52	3.91	4.16	18.54	18.40	115.88	115.00	0.34	0.38
T <sub>2</sub> N <sub>30</sub>	50.84	54.30	317.73	339.40	3.35	3.82	17.63	16.90	110.19	105.61	0.30	0.34
T <sub>2</sub> N <sub>45</sub>	52.83	55.43	330.21	346.46	3.78	4.18	16.11	16.73	100.71	104.58	0.30	0.34
T <sub>3</sub> N <sub>0</sub>	40.52	44.00	253.25	275.00	3.16	3.45	16.63	17.22	103.96	107.63	0.55	0.45
T <sub>3</sub> N <sub>15</sub>	50.05	53.62	312.81	335.13	4.47	4.96	16.03	16.37	100.17	102.31	0.34	0.38
T <sub>3</sub> N <sub>30</sub>	48.80	50.36	305.00	314.77	5.59	5.31	12.67	14.37	79.19	89.84	0.25	0.30
T <sub>3</sub> N <sub>45</sub>	42.66	42.35	266.6	264.71	3.54	3.89	14.79	15.34	92.44	95.90	0.32	0.36
F-test	**	**	**	**	**	*	*	*	*	*	**	**
L.S.D. 0.05	7.67	5.39	47.94	33.64	0.96	0.87	4.78	3.44	29.85	21.47	0.063	0.15

The interaction between nitrogen levels and nitrogen application times significantly affected N-content and protein content kg fed<sup>-1</sup> of faba bean straw and high significantly affected P-content.

The highest N-content values of 25.48 and 23.60 kg fed<sup>-1</sup> and the highest protein content values of 159.25 and 147.48 kg fed<sup>-1</sup> were recorded with T<sub>1</sub>N<sub>45</sub> treatment (45 kg N fed<sup>-1</sup> at sowing).

While the highest P-content of faba bean straw values of 0.55 and 0.45 kg fed<sup>-1</sup> were observed with zero nitrogen at the second irrigation (T<sub>3</sub>N<sub>0</sub>) treatment in the first and second season, respectively. These results are in agreement with those obtained by Soliman (1992) who found a gradual significant increase in seed yield fed<sup>-1</sup> was detected as the nitrogen level increased up to 48 kg N fed<sup>-1</sup>.

Data presented in Table 8 show that nitrogen levels clearly affected available nitrogen in the soil at harvest of faba bean in both seasons. The highest mean values of available N (37.33 mg N kg<sup>-1</sup> soil) was observed with N level of 45 kg N fed<sup>-1</sup> in both seasons.

Also, data show that nitrogen application time clearly affected the available nitrogen in the soil at harvest of faba bean in both seasons. The highest mean values of available N (34.55 and 34.1 mg N kg<sup>-1</sup> soil) were observed with T<sub>3</sub> treatment in the first and the second seasons, respectively. Application of the nitrogen in the late stage left less available N in the soil because the period between N application and soil samples was less than that of applying N fertilizer in the first period.

**Table 8: Effect of nitrogen levels, nitrogen application times and their interaction on available N and available P (mg kg<sup>-1</sup> soil) at harvest of faba bean in both seasons.**

Variables	Available N mg kg <sup>-1</sup> soil								Available P mg kg <sup>-1</sup> soil							
	1 <sup>st</sup>				2 <sup>nd</sup>				1 <sup>st</sup>				2 <sup>nd</sup>			
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	Mean	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	Mean	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	Mean	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	Mean
N <sub>0</sub>	28.0	28.0	28.0	28.0	24.3	24.3	24.3	24.3	15.0	15.0	15.0	15.0	16.5	16.5	16.5	16.5
N <sub>15</sub>	28.0	30.8	34.6	30.8	30.8	30.8	33.6	31.73	16.5	18.5	19.0	18.0	18.0	19.0	20.0	19.0
N <sub>30</sub>	30.8	36.4	36.4	34.53	33.6	33.6	39.2	35.47	16.0	17.5	17.5	17.0	17.5	19.0	17.5	18.0
N <sub>45</sub>	33.6	39.2	39.2	37.33	33.6	39.2	39.2	37.33	16.0	17.5	17.5	17.0	17.5	19.0	17.5	18.0
Means	30.1	33.6	34.55	-	30.58	31.98	34.1	-	15.88	17.13	17.25	-	17.88	8.38	17.88	-

Data presented in Table 8 clearly show that, the interaction between nitrogen levels and nitrogen application times affected the amount of available nitrogen in the soil at harvest of faba bean in both seasons. The highest available N values (39.2 g N kg<sup>-1</sup>) were observed with N levels of 45 kg N fed<sup>-1</sup> at the first irrigation (T<sub>2</sub>) and the second irrigation (T<sub>3</sub>) treatments in both seasons.

Generally, available N increased with increasing the levels of added nitrogen fertilizers at the same application time. For example: gradual increase in available N in the soil was observed as N rates increased. In case of T<sub>2</sub> treatment, the values increased from 28 mg kg<sup>-1</sup> with N<sub>0</sub> level (without nitrogen) to 30.8, 36.4 and 39.2 mg kg<sup>-1</sup> soil with N<sub>15</sub>, N<sub>30</sub> and N<sub>45</sub> treatments in the first season, respectively. Similar trend was obtained with the nitrogen levels in the second season. These results were in agreement with those obtained by Knany *et al.* (2004) and Atia (2005) who reported that, increasing N levels increased available N in the soil after soybean harvest.

Data presented in Table 8 show that, the nitrogen application times clearly affected the available phosphorus in soil at harvest of faba bean. The highest values were detected with the late treatments (T<sub>2</sub>, T<sub>3</sub>), while the lowest values were observed with T<sub>1</sub> treatment in the two seasons.

Results also show that increasing N levels led to decrease available-P. This may be attributed to that N addition enhanced plant growth and increased the uptake of the nutrients from the soil solution. These results are in agreement with those obtained by Atia (2005) who reported that increasing N levels led to decreasing available P in the soil after soybean harvest.



**Table 9: Income from faba bean investigation (L.E fed<sup>-1</sup>) due to nitrogen fertilization levels and application times in both seasons.**

Variable Treat.	Increasing of yield over control				Price of the increase L.E.				Total Price (LE)		Price of fert. year <sup>-1</sup>	Income (L.E. fed <sup>-1</sup> )	
	Seeds		Straw		Seeds		Straw		1 <sup>st</sup>	2 <sup>nd</sup>		1 <sup>st</sup>	2 <sup>nd</sup>
	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>					
T <sub>1</sub> N <sub>15</sub>	254	262	267	157	508	524	133.5	78.5	636.5	6025	30	636.5	572.5
T <sub>1</sub> N <sub>30</sub>	645	603	53	386	1290	1206	251.5	193	1541.5	13995	60	1481.5	1339
T <sub>1</sub> N <sub>45</sub>	155	113	1031	582	310	226	515.5	291	825.5	17	90	735.8	437
T <sub>2</sub> N <sub>15</sub>	164	131	-15	-126	328	264	-7.5	-63	320.5	2301	30	290.5	231
T <sub>2</sub> N <sub>30</sub>	255	235	40	-49	510	470	20	-24.5	530	445.5	60	470.0	385.5
T <sub>2</sub> N <sub>45</sub>	368	364	13	-65	736	728	6.5	-32.5	729.5	695.5	90	639.5	605.5
T <sub>3</sub> N <sub>15</sub>	263	250	5	-121	526	500	2.5	-60.5	528.5	439.5	30	498.5	409.5
T <sub>3</sub> N <sub>30</sub>	175	136	-346	-407	350	272	-173	-203.5	177.0	68.5	60	117.0	8.5
T <sub>3</sub> N <sub>45</sub>	115	156	-177	-248	230	112	-88.5	-124	141.5	-12	90	51.5	-78

Price of one kg seeds = 2 L.E      Price of one kg straw = 0.5 L.E      Price of one kg N = 2 L.E.

The reported data in Table 9 show that, in the first nitrogen application time (T<sub>1</sub>) (30 kg N fed<sup>-1</sup>) had the highest income of 1481.5 and 1339 LE fed<sup>-1</sup> in the first and second season, respectively. The sequence of income values was N<sub>30</sub> > N<sub>45</sub> > N<sub>15</sub> in both seasons. in the second application time (T<sub>2</sub>) the income values were increased according to increasing the nitrogen levels in both seasons. The highest income (639.5 and 605.5 LE fed<sup>-1</sup>) were obtained with application of 45 kg N fed<sup>-1</sup>. In the third application time the highest income values (498.5 and 409.5 LE fed<sup>-1</sup>) were obtained with application of 15 kg N fed<sup>-1</sup> in the first and second seasons respectively. The results show that the nitrogen application at late times led to decrease the income of faba bean yield.

### Conclusion

1. Application of nitrogen fertilizer at sowing time was the best treatment for increasing faba bean yield and yield components.
2. The highest values of faba bean seeds, straw yields, biological yield and 100-seeds weight were obtained from application of 30 kg N fed<sup>-1</sup> at sowing time.
3. The values of N-use efficiency were decreased with increasing the applied nitrogen.
4. Application of N at sowing time increased nitrogen and protein contents in faba bean straw.
5. The nitrogen, protein and phosphorus contents in seeds were highly significantly affected by nitrogen levels especially at T<sub>1</sub>N<sub>30</sub> treatment.
6. Available N after harvest in soil increased with increasing the levels of nitrogen fertilizers. Also, it increased at the late nitrogen application.
7. The highest income values were 1481.5 and 1339 LE fed<sup>-1</sup> in the first and second seasons, respectively was obtained with the addition of 30 kg N fed<sup>-1</sup> at sowing.

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## استجابة الفول البلدى لمستويات التسميد النيتروجيني ومواعيد الإضافة

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أجريت تجربتان حقليتان بمزرعة محطة البحوث الزراعية بسخا خلال الموسمين الشتويين ٢٠٠٣/٢٠٠٤ م ، ٢٠٠٤/٢٠٠٥ م على محصول الفول البلدى صنف جيزه ١٨٤ لدراسة أثر مستويات النيتروجين ومواعيد إضافته على إنتاجية الفول البلدى وبعض مكوناته.

استخدم تصميم القطع المنشقة فى أربع مكررات ، شغلت القطع الرئيسية بثلاثة مواعيد إضافة هى:

- ١- إضافة السماد النيتروجيني مع الزراعة.
  - ٢- إضافة السماد النيتروجيني مع الريه الأولى.
  - ٣- إضافة السماد النيتروجيني مع الريه الثانية.
- كما شغلت القطع الشقية بأربعة مستويات من التسميد النيتروجيني هى: صفر ، ١٥ ، ٣٠ ، ٤٥ كجم نيتروجين للفدان وكانت مساحة القطعة التجريبية ٩,٦ م<sup>٢</sup> وأجريت العمليات الزراعية الأخرى كما بالتوصيات.

وتتلخص النتائج المتحصل عليها فى الآتى:

كان لمواعيد إضافة السماد النيتروجيني تأثير عال المعنوية على محصول القش والمحصول الحيوى فى الموسمين. وقد أعطى ميعاد الإضافة الأولى (إضافة النيتروجين مع الزراعة) أعلى محصول حبوب (١٥٤١ ، ٦٢٤ كجم للفدان) وأعلى محصول قش (٢٧٦٣ ، ٢٧٤١ كجم للفدان) فى الموسم الأول والثانى على التوالى. بينما أعطى ميعاد الإضافة الثالث (إضافة النيتروجين مع الريه الثانية) أقل محصول حبوب وأقل محصول قش فى الموسمين.

كما كان لمستويات التسميد النيتروجيني تأثير عال المعنوية على محصول الحبوب ، ومحتواها من النيتروجين والبروتين والفوسفور وأيضا وزن الب ١٠٠ حبة فى كلا الموسمين ، وقد أدى التفاعل المشترك بين مواعيد إضافة النيتروجين ومستوياته تأثيرا عالى المعنوية على محصول الحبوب والقش وتأثيرا عال المعنوية على محتوى الحبوب من النيتروجين والبروتين والفوسفور ومحتوى القش من الفوسفور فى كلا الموسمين. بينما كان التأثير معنويا على محتوى القش من النيتروجين والبروتين فى الموسمين.

وقد أدت زيادة مستويات التسميد النيتروجيني لزيادة واضحة فى النيتروجين الميسر فى الارض بعض الحصاد فى الموسمين. أيضا أثرت مواعيد إضافة النيتروجين على النيتروجين الميسر على الترتيب الآتى: الميعاد الثالث < الميعاد الثانى < الميعاد الأول. وقد أعطت المعاملة ٣٠ كجم نيتروجين عند الزراعة أعلى عائد مادى حيث كان ١٤٨١,٥ ، ١٣٣٩ جنيه مصرى لكل فدان للموسم الاول والثانى على التوالى.

