RESULTS AND DISCUSSION

4. RESULTS AND DISCUSSION

4.1. Vegetative growth characteristics:

Data presented in Tables (1, 2 and 3) show the effect of seed sowing rate, nitrogen and phosphorus fertilizers levels as well as their interactions on different studied vegetative growth charateristics, i.e. plant height, number of leaves and branches, fresh and dry weight per plant, of common bean plants.

4.1.1) Effect of sowing rate:

Data shown in Table (1) reveal that increasing the rate of sowing seeds per faddan from 20, 30 up to 40 kg significantly affected all studied parameters. Such results showed that there were continuous, gradual and significant reduction in values of most plant growth characteristics with increasing sowing rate. It is worthy to notice that similar trend was observed during both growing seasons of this trial. Such results may be attributed to the high photosynthetic rate especially at wider spacing that achieved by the lower rate of seeds (20 kg seeds/fad.) and consequently such conditions permitted high nutrient uptake by the common bean plants.

Concerning the effect of sowing rate on plant height, it is evident that using either 20 or 40 kg seeds/fad. significatly increased plant height than using 30 kg seeds/fad. Such data are logically expected, where plants that grown at wider spacing (20 kg seeds/fad.) have chance to grow better than that grown at medium one (30 kg seeds/fad.). Meanwhile, those grown at narrow spacing (40 kg seeds/fad.) suffer from the competition between plants which in turn pushed the plants to be more taller searching for light.

Table (1): Effect of sowing rate, nitrogen or phosphorus fertilization level on the growth characteristics of common bean plants.

Characters / Treatments	1992					1993				
	Plant height (cm)	No. of leaves/ plant	No. of branches/ plant	Fresh weight/ plant (g)	Dry weight/ plant (g)	Plant height (cm)	No. of leaves/ plant	No. of branches/ plant	Fresh weight/ plant (g)	Dry weight/ plant (g)
Effect of sowing rate										
kg seed/fad.										
20	37.1	13.4	9.9	38.8	8.3	48.5	15.2	10.2	61.4	10.9
30	36.1	12.7	9.9	32.8	6.9	45.2	15.1	9.1	56.2	9.9
40	37.1	12.8	8.7	32.5	6.6	48.0	13.7	9.0	50.5	10.0
L.S.D. at 0.05	0.7	0.07	0.2	0.7	0.1	0.4	0.4	0.3	0.8	0.3
Effect of N-level										
Kg N/fad.										
30	35.2	11.2	9.3	32.3	6.6	43.0	13.5	9.1	50.4	9.3
60	36.8	13.5	9.5	36.2	7.6	46.9	14.7	9.3	58.5	10.7
90	38.3	14.2	9.7	36.7	7.6	51.8	15.9	10.1	59.2	10.9
L.S.D. at 0.05	0.5	0.3	N.S.	0.4	0.2	0.8	0.4	0.2	0.4	0.3
Effect of P-level										
Kg P_2O_5/fad.										
32	36.3	11.4	8.9	30.1	6.2	46.2	14.2	9.0	54.4	9.3
64	36.7	13.5	9.6	35.8	7.3	47.3	14.6	9.5	55.3	10.0
96	37.3	14.0	10.0	38.3	8.4	48.2	15.2	10.0	58.5	11.4
L.S.D. at 0.05	0.4	0.4	0.2	0.5	0.2	0.3	0.3	0.3	0.6	0.2

The obtained results are in agreement with those of Quintero (1986) and Abaza (1991) on common bean who indicated that plant height was increased with increasing plant density. Moreover, obtaind results are in confirmity with those reported by Bakry *et al.* (1984) on peas and Nigem *et al.* (1988-a) on broad bean who found that increasing plant population increased plant height. Similar, results were also obtained by Pawlowski *et al.* (1990) on soybean who showed that plant height was increased by increasing sowing rate. On the other hand, obtained results dealing with the effectivness of using 20 kg seeds/fad. are in harmony with those of El-Bakry (1966) on snap bean who found that reducing plant population per faddan increased plant height. However, contra results were reported by many investigators on different legume crops, among them Kamel *et al.* (1982), Griffin *et al.* (1983), Morsy (1986) and Amer *et al.* (1992) who found that increasing plant spacing or plant density did not affect plant height.

Dealing with number of leaves per plant, obtained results are in agreement with those of Abd-El-Razik (1978), El-Afifi and Darweesh (1990) and Abaza (1991) on beans who found that increasing plant density decreased number of leaves/plant. Similar results were also obtained on different legume crops, i.e. Costa and Pendleton (1979), Tunio *et al.* (1980) on soybean, Remison (1980) and Morsy (1986) on cowpea, Sahria (1981) and Bakry *et al.* (1984) on peas and Nigem *et al.* (1988-a) on broad bean

Concerning number of branches per plant, obtained results agree with those reported by Abaza (1991) on common bean who found that higher plant density decreased number of shoots/plant. Similar findings were also reported by Remison (1980) and Saleh *et al.* (1980) on cowpea, Salem and El-Massri (1986), Nigem *et al.* (1988-a) and Amer *et al.* (1992) on *Vicia fada* and Bakry *et al.* (1984) on peas who stated that number of branches/plant was decreased by increasing plant stand. However, contra results were

obtained by Shafik *et al.* (1988) on *Vicia faba* who indicated that number of branches/plant was unaffected by row spacing.

With respect to fresh weight per plant, obtained results are in agreement with those indicated by Abd-El-Razik (1978), Babillo *et al.* (1978), Cyril (1980), Mahatanya (1980) and Abaza (1991) all working on beans and Morsy (1986) on cowpea who noticed that increasing plant density decreased fresh weight/plant.

Concerning the dry weight per plant, obtained data are coincided with those of Thimmegowda *et al.* (1974), Gad El-Hak and Mahmoud (1988) El-Afifi and Darweesh (1990) and Abaza (1991) on beans who found that increasing plant density decreased plant dry weight. Similar findings were also reported by Mahmoud (1977), Morsy (1986), Nigem *et al.* (1988-a), Farrag (1991), Lejeune (1991) and Lin *et al.* (1991) on different legume crops. However, contra results were found by Enyi (1975) on common bean who indicated that increasing plant population increased whole plant dry weight.

4.1.2. Effect of nitrogen fertilization level:

Data illustrated in Table (1) show the effect of nitrogen fertilization level on different studied vegetative growth characteristics of common bean plants. It is clearly evident from such data that using 90 kg N/fad. resulted in the highest values in this respect. Moreover, the superiourity of the highest used level (90 kg N/fad.) over that of the medium (60 kg N/fad) or the low one (30 kg N/fad) was significant in the two seasons of this work. Obtained data may be attributed to the role of nitrogen element in plant which was demonstrated by Bidwell (1979) and Edmond *et al.* (1981) who concluded that nitrogen is an indispensable elementray constituent of numerous organic compounds of general importance (amino acids, protein, nuclic acids) and it is needed for the formation of protoplasm and new cells, as well as, its encouragement for cell elongation. In addition, nitrogen deficiency

is characterized by a poor growth rate, the leaves remain small and stem have a spindly apperance.

Although, legumes are capable to utilize the atmospheric nitrogen through the Rhizobium bacteria found in nodules of their plant roots, the levels of nodulation and nitrogen fixation of phaseolus beans are low and variable, thus nitrogenous fertilizers are recommended for bean to stimulate plant growth. Many investigators studied this point among them were Cackett (1965), Stephens (1967) and Habbish and Ishag (1974).

Concerning the effect of nitrogen fertilization level on plant height, obtained results are in agreement with those reported by Lluch *et al.* (1983), Khalil *et al.* (1985), Farag *et al.* (1987) and Abou-El-Hassan *et al.* (1993) on bean who showed that increasing N-application rate increased plant height. Similar results were also obtained by Hassan *et al.* (1989) and Khalil (1990) on cowpea, El-Beheidi *et al.* (1984) and Khalil (1990) on peas and Farag *et al.* (1989) on *Vicia faba*. On the contrary, the obtained result disagree with that reported by Solh *et al.* (1986) on soybean who indicated that increasing N-rate had no effect on plant height.

Dealing with number of leaves per plant, such results are in agreement with those obtained by Khalil *et al.* (1985), Farag *et al.* (1987) and El-Asdoudi *et al.* (1989) on bean who stated that number of leaves per plant was increased by increasing N-rate. In this respect, similar results were obtained by Farag *et al.* (1989) on *Vicia faba*, Khalil (1990) on peas and Khalil (1990) on cowpea. Contra results were obtained by Chui (1985) on *Phaseolus vulgaris* and Morsy (1986) on cowpea who found that number of leaves/plant was not affected by increasing N-level.

Concerning number of branches per plant, obtained results are in harmony with those of Khalil *et al.* (1985) and El-Asdoudi *et al.* (1989) on beans who noticed that increasing N-level increased number of branches/plant. Similar findings were also

found by Farag *et al.* (1989) on *Vicia faba*, Khalil (1990) on cowpea and Khalil (1990) on peas. On the contrary to the previous results, Saleh *et al.* (1980) on cowpea and Hassan *et al.* (1993-a) on peas stated that nitrogen level did not affect number of branches/plant.

Regarding plant fresh weight, obtained results are going in agreement also with those reported by Velaquez *et al.* (1988) on *Phaseolus vulgaris*, El-Neklawy *et al.* (1985) on pea, Morsy (1986) on cowpea and Farag *et al.* (1989) on *Vicia faba* who concluded that fresh weight/plant increased with increasing N-rate.

With respect to the effect of N-fertilization on dry weight per plant, the results reported herein are in agreement with those obtained by Khalil *et al.* (1985), Farag *et al.* (1987), El-Asdoudi *et al.* (1989) and Abou El-Hassan *et al.* (1993) on beans who found that increasing N-level increased plant dry weight. Similar results were also obtained by El-Beheidi *et al.* (1984), El-Neklawy *et al.* (1985), Kalifa (1987), Farag *et al.* (1989), Hassan *et al.* (1989), Farrag (1991) and Khalil (1990 and 1990) on different legume crops. However, contra results were obtained by Morsy (1986) on cowpea who noticed that increasing nitrogen fertilizer had no effect on the dry matter content of plant.

4.1.3) Effect of phosphorus fertilization level:

With regard to the effect of phosphorus fertilization on growth features of common bean plants, expressed as, plant height, number of both leaves and branches per plant as well as the fresh and dry weight per plant, results presented in Table (1) indicate that there was a consistant and significant increase in the different studied vegetative growth parameters of bean plants by increasing the application level of phosphorus fertilizer up to the highest used level, i.e. 96 kg P_2O_5/fad. This effect of phosphorus may be due to its enhancing influence on photosynthesis and respiration as reported by Repka (1979) who observed that phosphorus deficiency and excess increased respiration and

reduced photosynthesis, Whereas the optimal levels had the opposite effect and produced the best plant growth of phaseolus beans. Furthermore, Bidwell (1979) and Edmond *et al.* (1981) added that phosphorus is a part of molecular stucture of several vitally important compounds notable nuclic acids (DNA, the two forms of RNA). In addition, phosphorus plays indispensable role in the enzyme system necessary for the energy transform in photosynthetic and respiration, it is also a constituent of cell nucleus and essential for division and for the development of meristematic tissue.

With regard to the effect of phosphorus fertilization on plant height, results of this work coincided also with those obtained by El-Bakry *et al.* (1980), Mahatanya (1980), Acuna and Cordero (1989) and Abou El-Hassan *et al.* (1993) on beans who found that plant height increased by increasing phosphorus fertilizer level. Similar results were also obtained by Goverdhan Singh (1985) and Hassan *et al.* (1990) on cowpea, Hassan *et al.* (1993-a) on peas, Salem and El-Massri (1986) and Etman *et al.* (1991) on *Vicia faba* and Prasad *et al.* (1991) on soybean. On the contrary, the obtained results disagreed with those reported by El-Sawah *et al.* (1985) on broad bean who showed that increasing phosphorus application decreased plant height. Meanwhile, Farag *et al.* (1987) on cowpea reported that plant height was not affected by increasing P_2O_5 level.

Dealing with number of leaves/plant, obtained results are in agreement with those reported by Manrique (1986), Jonathan *et al.* (1991) and lynch *et al.* (1991) on beans who found that increasing P_2O_5 application level increased number of leaves/plant Similar findings were also shown by Abd El-wahab *et al.* (1979), Farag *et al.* (1987), Omar *et al.* (1990) and Etman *et al.* (1991) on different legume crops.

Concerning number of branches per plant, obtained results are in confirmity with those reported by Jonathan *et al.* (1991) and

Lynch *et al.* (1991) on beans who indicated that number of branches per plant was increased with increasing phosphorus fertilizer rate. Similar trend was also obtained by Abd El-Wahab *et al.* (1979), Mahboob *et al.* (1984), El-Sawah *et al.* (1985), Kothari and Saraf (1986), Salem and El-Massri (1986), Omar *et al.* (1990), Etman *et al.* (1991) and Hassan *et al.* (1993-a) on different legume crops. However, contra results were obtained by Farag *et al.* (1987) on cowpea who reported that number of branches/plant was not affected by increasing P_2O_5 level.

With respect to plant fresh weight, obtained results are in agreement with those reported by El-sawah *et al.* (1985) on broad bean who stated that plant fresh weight increased by increasing phosphorus application. On the contrary, the obtained results disagree with those reported by Araujo *et al.* (1982) on bean who indicated that increasing rate of phosphorus fertilizer did not influence plant fresh weight.

Concerning dry weight per plant, similar findings were also reported by Ssali and Keya (1983), Chagas *et al.* (1987), Neptune and Perez (1987), Jonathan *et al.* (1991) and Abou El-Hassan *et al.* (1993) on beans who noticed that phosphorus deficiency reduced plant dry weight. In this respect, Abd El-Wahab *et al.* (1979), and El-Sawah *et al.* (1985) on *Vicia faba*, Midan *et al.* (1982) on peas, Farag *et al.* (1987) and Hassan *et al.* (1990) on cowpea demonstrated that dry weight/plant was increased by increasing level of phosphorus application. However, contra results were found by El-Bakry *et al.* (1980) on snap bean who reported that phosphorus fertilizer had no effect on dry weight of both leaves and stem.

4.1.4. Effect of first order interaction between sowing rate and nitrogen fertilization level:

Data illustrated in Table (2) show that the interaction of sowing rate with nitrogen fertilization on growth characters of common bean plants was statistically significant in both seasons of

growth. It is obvious from such data that using either 20 or 30 kg seeds/fad. within application of 60 or 90 kg N/fad. showed mostly the highest values in this respect. Similar results were also obtained by Morsy (1986) on cowpea regarding number of leaves and branches as well as dry weight per plant which were increased in wider spacing (40 cm) within high nitrogen fertilization level (150 kg calcium nitrate/fad.). On the other hand, contra results were obtained by Morsy (1986) on cowpea concerning plant height and fresh weight/plant where he found that such characters were not affected by increasing plant spacing up to 40 cm within high nitrogen fertilizer up to 150 kg calcium nitrate/fad.

4.1.5. Effect of first order interaction between sowing rate and phosphorus fertilization level:

Data shown in Table (2) reveal that using 20 kg seeds/fad. and application of 96 kg P_2O_5/fad. resulted in the highest values of most of the different studied plant growth parameters at both seasons of this work. Such results are expected where the same level of phosphorus and also the same rate of seed sowing when acting each alone were of superior effect in this respect.

4.1.6. Effect of first order interaction between nitrogen and phosphorus fertilization levels:

The illustrated data in Table (2) show that application of 60 kg N-in combination with 96 kg P_2O_5/fad. produced plants of the highest growth features in both growth seasons. Moreover, obtained increments were statistically significant in most cases. Such findings are expected where the levels of 60 kg N-and 96 kg P_2O_5/fad. were the most effective levels, in case of studying the main effect of each of either N or P in this respect. These results were in agreement with those obtained by Smith (1977), Chandra *et al.* (1987) and Srinivas and Naik (1990) who reported that vegetative growth of bean plants increased with receiving nitrogen and phosphorus fertilization.

Table (2): Effect of first order interaction between sowing rate and/or nitrogen and phosphorus fertilization level on the growth characteristics of common bean plants.

Characters / Treatments		1992 Plant height (cm)	1992 No. of leaves/ plant	1992 No. of branches/ plant	1992 Fresh weight/ plant (g)	1992 Dry weight/ plant (g)	1993 Plant height (cm)	1993 No. of leaves/ plant	1993 No. of branches/ plant	1993 Fresh weight/ plant (g)	1993 Dry weight/ plant (g)
N sow. rate kg/fad.		**Effect of sow.rate X N-level**									
	20	35.9	11.6	9.3	35.7	7.4	44.7	11.7	9.2	49.6	10.6
30	30	35.1	10.7	9.7	28.5	5.8	40.7	13.3	9.1	48.4	6.6
	40	37.7	11.4	9.1	32.7	6.7	43.7	15.4	8.9	53.3	10.6
	20	39.1	14.3	9.9	38.5	8.6	48.1	13.8	9.6	58.1	12.9
60	30	38.3	12.6	9.0	32.4	6.8	43.4	16.5	9.3	63.8	12.1
	40	39.0	13.6	9.5	37.6	7.5	49.2	16.7	8.9	53.4	10.9
	20	36.5	14.4	10.5	42.3	9.0	52.6	15.5	11.8	76.4	9.2
90	30	34.9	14.7	11.0	37.4	8.2	51.5	15.5	8.9	56.3	11.0
	40	34.6	13.5	7.6	27.3	5.7	51.1	13.6	9.7	44.8	8.5
L.S.D. at 0.05		0.9	0.6	0.5	0.7	0.4	1.3	0.6	0.4	0.8	0.6
P_2O_5 sow.rate kg/fad.		**Effect of sow.rate X P-level**									
	20	37.1	11.8	8.4	31.4	6.2	44.1	12.2	9.0	55.4	8.7
32	30	35.2	11.2	9.4	29.6	6.5	46.2	15.4	9.0	58.6	9.7
	40	36.5	11.2	8.8	29.2	5.9	48.2	14.9	8.9	49.1	9.6
	20	37.2	13.9	10.0	40.1	8.7	49.4	13.6	10.4	61.6	10.3
64	30	36.2	13.4	10.1	33.1	6.8	44.5	14.9	8.9	54.1	9.7
	40	36.8	13.3	8.7	34.2	6.5	48.2	15.4	9.1	50.0	10.0
	20	37.1	14.5	11.3	45.1	10.1	52.0	15.3	11.2	67.1	13.7
96	30	36.8	13.3	10.2	35.6	7.4	44.9	15.0	9.4	55.8	10.3
	40	38.0	14.0	8.6	34.2	7.6	47.6	15.4	9.5	52.5	10.3
L.S.D. at 0.05		0.6	N.S.	0.4	0.9	0.5	0.6	0.6	0.5	1.0	0.5
N P_2O_5 kg/fad		**Effect of N X P-levels**									
	32	33.7	9.7	8.5	25.8	5.2	41.1	12.6	8.2	46.8	7.7
30	64	36.7	11.2	9.4	33.3	6.4	42.7	13.5	8.8	49.9	8.8
	96	38.2	12.7	10.2	37.8	8.4	45.2	14.3	10.1	54.7	11.3
	32	37.0	10.8	8.0	28.1	5.6	42.2	14.4	8.5	53.2	10.0
60	64	38.9	15.1	9.6	38.0	8.0	48.2	15.7	9.3	58.9	12.0
	96	40.4	14.6	10.8	42.4	9.3	50.3	17.0	10.0	63.4	13.9
	32	38.1	13.7	10.2	36.3	7.8	55.1	15.6	10.1	63.1	10.3
90	64	34.6	14.3	9.8	36.1	7.5	51.1	14.6	10.3	57.1	9.1
	96	33.3	14.6	9.1	34.7	7.5	49.0	14.4	9.9	57.3	9.2
L.S.D. at 0.05		0.6	0.7	0.4	0.9	0.5	0.6	0.6	0.5	1.0	0.5

Obtained results are also in agreement with those of El-Abedeen *et al.* (1983) and Abou El-Hassan *et al.* (1993) on beans who found that plant height increased by using N and P fertilizers. Similar results were also reported by Abaza (1991) and Smithson *et al.* (1993) on common bean and Bakry *et al.* (1984) on peas who noticed that plant height was increased by increasing N, P and K fertilizers level. On the other hand, contra results were obtained by El-Bakry *et al.* (1980) on bean who found that there was no interaction between phosphorus and nitrogen fertilizers on plant height. Similar results were also noticed by saleh *et al.* (1980) on cowpea who found that N, P and K fertilizers did not reflect any effect on stem length.

Concerning number of leaves per plant, obtained results are in harmony with those of El-Abedeen *et al.* (1983), on *Phaseolus vulgaris* who reported that number of leaves/plant increased by increasing NP fertilization. Similar results were also noticed by El-Afifi and Darweesh (1990) and Abaza (1991) on beans and Bakry *et al.* (1984) on peas who indicated that increacing N, P and K fertilization increased number of leaves/plant.

Dealing with number of branches per plant, similar findings were also reported by Abaza (1991) on bean and Bakry *et al.* (1984) on pea who reported that number of branches per plant increased by increasing N, P and K fertilizers level. On the contrary, Saleh *et al.* (1980) on cowpea indicated that increasing the applied fertilizers level did not increase number of branches/ plant.

With regard to plant fresh weight, obtained results are in agreement with those reported by Cyril (1980) and Abaza (1991) on beans who demostrated that fresh weight per plant increased by increasing NPK application rate.

Concerning plant dry weight, obtained results coincide with those obtained by Ssalil and keya (1986) and Abou El-Hassan *et*

al. (1993) on beans who found that plant dry weight increased by using nitrogen and phosphorus fertilizers. Similar findings were noticed by El-Afif and Darweesh (1990), Abaza (1991) and Radoglou and Jarvis (1992) on beans and Bakry *et al.* (1984) on peas who showed that high NPK nutrients supply increased plant dry weight. On the contrary, El-Bakry *et al.* (1980) on bean stated that neither leaves nor stem dry weight per plant were affected by NP fertilizers application levels.

4.1.7. Effect of second order interaction among sowing rate, nitrogen and phosphorus fertilization levels:

Data reported in Table (3) show the effect of tri-interaction between seed sowing rate within nitrogen and phoshorus fertilization level on the growth characteristics of common bean plants. It is evident from such data that using 20 kg seeds/fad. and application of the highest used level of both nitrogen (90 kg N/fad.) and phosphorus (96 kg P_2O_5/fad.) fertilizers resulted mostly in the highest values of different studied plant growth parameters except of that of plant height which behaved in a different manner. These results were the same at both seasons of this work.

With regard to the effect of interaction among sowing rate combined with N and P fertilization level on plant height, obtained results were also reported by Abaza (1991) on bean and Bakry *et al.* (1984) on peas who noticed that there was an interaction between increasing plant population within NPK fertilizers/fad. on increasing plant height. On the contrary, Cyril (1980) on bean proved that a higher rate of NP fertilizers combined with a higher plant stand was not needed to increase plant growth.

Concerning number of leaves per plant, obtained results are in agreement with those reported by Abaza (1991) on bean who found that wide spacing combined with NPK fertilizers showed

Table (3): Effect of second order interaction among sowing rate, nitrogen and phosphorus fertilization level on the growth characteristics of common bean plants.

Characters / Treatments			1992					1993				
			Plant height (cm)	No. of leaves/ plant	No. of bran-ches/ plant	Fresh weight/ plant (g)	Dry weight/ plant (g)	Plant height (cm)	No. of leaves/ plant	No. of bran-ches/ plant	Fresh weight/ plant (g)	Dry weight/ plant (g)
Ferti. level N	P_2O_5	sow. rate kg/fad.	**Effect of sow.rate X N X P-levels**									
		20	33.3	10.6	8.0	31.6	5.4	42.0	11.4	7.8	45.2	7.6
	32	30	33.1	9.3	8.9	23.1	5.2	39.4	12.1	8.6	44.6	5.7
		40	34.8	9.3	8.7	22.8	5.0	41.9	14.2	8.3	50.6	9.7
		20	37.0	11.8	9.5	36.7	7.3	43.3	11.6	9.0	49.7	9.6
30	64	30	35.6	10.5	9.5	27.0	5.4	40.9	13.2	8.7	47.5	6.2
		40	37.5	11.3	9.0	36.2	6.5	43.8	15.7	8.8	52.4	10.7
		20	37.3	12.2	10.3	38.8	9.6	48.7	12.1	10.8	54.1	14.7
	96	30	36.6	12.2	10.6	35.4	6.9	41.6	14.6	10.1	53.0	7.7
		40	40.7	13.6	9.6	39.3	8.6	45.3	16.3	9.5	57.1	11.4
		20	37.6	11.3	7.7	27.4	5.4	38.9	11.5	9.1	51.8	10.3
	32	30	35.3	9.6	7.5	25.5	5.5	42.0	16.0	8.5	58.5	9.8
		40	38.1	11.5	8.7	31.5	6.0	45.7	15.7	8.0	49.2	9.8
		20	39.8	16.0	9.5	40.5	9.8	51.9	13.8	9.8	58.8	12.4
60	64	30	38.5	14.7	9.8	34.8	6.9	43.0	16.5	9.0	64.0	12.7
		40	38.5	14.6	9.4	38.8	7.4	49.9	16.8	9.0	53.7	11.1
		20	39.8	15.7	12.3	47.6	10.6	53.5	16.3	10.0	63.8	16.1
	96	30	41.0	13.5	9.8	36.8	8.0	45.3	17.1	10.4	68.9	13.7
		40	40.5	14.7	10.3	42.6	9.2	52.1	17.6	9.7	57.4	11.8
		20	40.4	13.5	9.5	35.2	7.8	51.3	13.6	10.1	69.3	8.2
	32	30	37.1	14.8	12.0	40.2	8.9	57.2	18.2	9.9	72.3	13.5
		40	36.6	12.9	9.1	33.5	6.7	56.9	14.9	10.2	47.5	9.3
		20	34.9	14.1	11.0	43.0	8.9	52.8	15.3	12.4	76.5	8.9
90	64	30	34.5	14.9	10.9	37.6	8.1	49.5	14.9	9.0	50.7	10.2
		40	34.5	13.9	7.6	27.7	5.5	51.1	13.6	9.5	44.0	8.3
		20	34.2	15.5	11.1	48.8	10.2	53.8	17.7	12.8	83.4	10.4
	96	30	33.0	14.4	10.2	34.6	7.4	47.8	13.4	7.7	45.6	9.4
		40	32.7	13.8	6.1	20.7	4.9	45.4	12.3	9.3	43.0	7.8
L.S.D. at 0.05			1.0	1.2	0.8	1.5	0.8	1.1	1.1	0.8	1.7	0.9

significant effect in this respect. However, contra results were obtained by Bakry *et al.* (1984) on pea who indicated that there was an interaction between increasing plant population within NPK fertilization level on increasing number of leaves/plant.

Dealing with number of branches per plant, obtained findings are in accordance with those reported by Bakry *et al.* (1984) on peas who found that number of branches/plant was increased by medium plant population within NPK fertilization whereas decreased by increasing plant population. However, obtained results disagreed with those reported by Abaza (1991) on bean who indicated that number of shoots/plant was not affected by interaction between increasing plant density within NPK fertilization used treatments.

With regard to plant fresh weight, the obtained results coincide with those reported by Abaza (1991) on bean who found that fresh weight per plant was increased as a result of interaction between the lowest density and the highest NPK fertilization treatments.

With regard to plant dry weight, obtained results are in confirmity with those showed by Bakry *et al.* (1980) on peas and Farrag (1991) on cowpea who noticed that the highest dry matter content of both plant leaves and stem had bean found as a result of the interaction between the lowest plant density within the highest level of NPK fertilization. On the contray, Abaza (1991) on bean reported that dry weight per plant was not affected by the interaction between increasing plant density combined with NPK fertilization treatments.

4.2. Chemical composition of plant leaves:

4.2.a. Photosynthetic pigments content:

The effect of sowing rate, nitrogen and phosphorus fertilizers application and their interactions on a, b and total chlorophyll as

well as carotenoids content of bean plant leaves are given in Tables (4, 5 and 6).

4.2.a.1. Effect of sowing rate:

Data tabulated in Table (4) show clearly that sowing rate had a marked effect on photosynthetic pigments content of bean leaves. The heighest values of a, b and total chlorophyll as well as carotenoids were obtained by the lowest seed sowing rate (20 kg seeds/fad.). Moreover, the content of photosynthetic pigments of bean leaves was gradually and significantly increased by decreasing sowing rate from 40 kg up to 20 kg seeds/fad. Similar trend was observed during both growing seasons except chlorophyll b in the first season. Such high efficiency of building photosynthetic pigments by plants grown at lower seed rate is expected as a result of plants have strong vegetative growth (Table,1) with active photosynthetic apparatus. Obtained result disagreed with those reported by El-Afifi and Darweesh (1990) and Abaza (1991) on beans who found that increasing plant density did not affect a, b and total chlorophyll. Moreover, similar disagreement was repored by, Morsy (1986) on cowpea who reported that chlorophyll a, b and carotenoids content of leaves were not increased by increasing plant spacing.

4.2.a.2. Effect of nitrogen fertilization level:

With regard to the effect of nitrogen fertilization level on photosynthetic pigments content on bean leaves, the results reported in Table (4), generally show that such content increased by increasing nitrogen application from 30 kg N/fad. up to medium used level (60 kg N/fad.) in the first season and up to the highest level, i.e. 90 kg N/fad. in the second season. The increment in chlorophyll and carotenoids with the addition of nitrogen is probably due to that nitrogen is a constituent of chlorophyll molecule. Moreover, nitrogen also increases the constancy of chlorophyll. Thus, it leads to decrease it 's destruction and finally to the increase in carotenoids, which in turn, protect chlorophyll

Table (4): Effect of sowing rate, nitrogen or phosphorus ferilization level on the photosynthetic pigments content (mg/100 g D.W.) of common bean plant leaves.

Characters / Treatments	1992				1993			
	Chlorophyll			Carot-enoids	Chlorophyll			Carot-enoids
	a	b	Total a + b		a	b	Total a + b	
kg seed /fad.	**Effect of Sowing rate**							
20	367.8	180.6	548.8	206.9	432.1	239.8	672.0	205.4
30	352.0	163.9	516.3	200.1	410.9	181.8	592.7	201.3
40	336.3	171.5	508.2	199.5	379.6	155.8	535.4	192.0
L.S.D. at 0.05	1.2	6.8	8.6	3.8	7.7	3.6	8.4	2.5
Kg N/fad.	**Effect of N-level**							
30	343.7	168.5	512.2	202.7	380.7	200.5	581.2	204.0
60	369.5	163.6	534.1	202.2	408.2	180.7	588.9	206.4
90	343.0	183.9	526.9	201.7	433.7	196.2	629.9	188.3
L.S.D. at 0.05	2.2	8.4	8.7	N.S.	5.5	3.5	4.5	2.6
Kg P_2O_5/fad.	**Effect of P-level**							
32	347.0	173.7	520.7	193.2	390.7	198.6	589.3	188.4
64	369.0	173.2	542.2	216.6	427.4	207.1	634.3	225.2
96	340.1	169.2	510.3	196.8	404.5	171.7	576.2	185.0
L.S.D. at 0.05	2.4	N.S.	5.8	2.2	6.3	2.8	7.2	2.4

againest oxidation. Obtained results in this respect coincide with those of El-leboudi *et al.* (1974), Koinov and Petkov (1975), Farag *et al.* (1987) and Radoglou and Jarvis (1992) on beans who found that increasing N-rate increased a, b and total chlorophyll as well as carotenoids concentrations of plant leaves. Similar findings were also obtained by Gambarova *et al.* (1978) and El-Beheidi *et al.* (1984) on pea and Khalil (1990) on cowpea. However, contra results were reported by Morsy (1986) on cowpea who noticed that the leaves content of photosynthetic pigments was not increased with increasing nitrogen application.

4.2.a.3. Effect of phosphorus fertilization level:

Results shown in Table (4) illustrate that a, b and total chlorophyll as well as carotenoids leaves content significantly increased with increasing phosphorus fertilizer level from 32 to 64 kg P_2O_5/fad. However, increasing P-level up to 96 kg P_2O_5/fad. resulted in decreasing values of studied pigments. It is also evident that results behaved the same at both growing seasons. obtained results are in agreement with those reported by El-Mansi *et al.* (1991) on broad bean who demonstrated that P_2O_5 as a foliar nutrition increased the photosynthetic pigments content.

4.2.a.4. Effect of first order interaction between sowing rate and nitrogen fertilization level.

Data presented in Table (5) show that the combined effect of sowing rate and nitrogen fertilization significantly affected the contents of both chlorphyll and carotenoids in both seasons of growth. It is obvious from such data that this effect was more pronounced mostly using 20 kg seeds/fad. within application of nitrogen fertilizer at 60 or 90 kg N/fad.

Obtained results are in confirmity with those reported by Morsy (1986) on cowpea who found that there was a significant interaction between plant spacing and nitrogen fertilizer in this respect.

Table (5): Effect of first order interaction between sowing rate and/or nitrogen and phosphorus fertilization level on the photosynthetic pigments content (mg/100 g D.W.) of common bean plant leaves.

Characters / Treatments		1992				1993			
		Chlorophyll			Carot-enoids	Chlorophyll			Carot-enoids
		a	b	Total a + b		a	b	Total a + b	
N	sow.rate kg/fad.	Effect of sow.rate X N-level							
	20	317.7	150.3	468.0	176.6	366.8	222.7	289.5	190.5
30	30	379.4	185.4	564.8	218.0	378.1	219.1	597.2	189.8
	40	333.9	169.7	503.6	213.0	397.1	192.8	589.9	231.6
	20	392.2	172.5	564.7	211.5	431.7	213.3	645.0	245.4
60	30	340.7	143.2	483.9	188.5	428.2	212.3	640.5	202.3
	40	375.3	174.9	550.2	206.3	364.5	149.5	514.0	171.3
	20	393.5	219.0	612.5	232.7	497.7	216.8	714.5	180.2
90	30	335.8	163.1	498.9	193.7	426.3	147.0	573.3	211.6
	40	299.5	169.6	469.1	178.6	376.9	158.1	535.0	172.9
L.S.D. at 0.05		3.9	14.6	15.1	4.3	9.9	6.0	7.8	4.5
P_2O_5	sow.rate kg/fad.	Effect of sow.rate X P-level							
	20	362.0	161.5	523.5	207.6	389.1	222.3	611.4	200.0
32	30	325.5	168.7	494.2	164.5	400.4	209.7	610.1	184.9
	40	353.5	190.9	544.4	207.4	382.5	164.8	547.3	180.3
	20	413.1	214.5	627.6	222.0	467.5	283.3	750.8	228.8
64	30	391.8	156.0	547.8	225.8	427.2	177.1	604.3	231.5
	40	302.0	148.9	450.9	201.8	387.3	158.8	546.1	215.3
	20	328.2	165.8	494.0	191.3	439.6	211.8	651.4	187.3
96	30	338.7	167.1	505.8	210.0	405.0	159.5	564.5	187.3
	40	353.3	174.4	527.7	188.9	368.8	144.7	513.5	180.3
L.S.D. at 0.05		4.2	11.5	10.0	3.8	10.9	4.8	12.5	4.2
N	P_2O_5 kg/fad.	Effect of N X P-levels							
	32	310.5	141.1	451.6	181.1	363.8	227.3	591.1	171.9
30	64	331.7	161.2	492.9	211.1	399.0	216.9	615.9	233.6
	96	388.8	203.1	591.9	215.6	379.2	157.2	536.4	206.4
	32	395.0	183.0	578.0	205.0	361.8	177.4	539.2	181.3
60	64	375.8	174.2	550.0	225.3	450.4	208.7	659.1	256.4
	96	337.4	133.4	470.8	176.1	412.3	155.7	568.0	181.3
	32	335.4	196.9	532.3	193.4	446.4	191.0	637.4	212.0
90	64	399.4	183.9	583.3	213.1	432.6	195.6	628.2	185.5
	96	293.9	170.8	464.7	198.4	421.9	202.0	623.9	167.2
L.S.D. at 0.05		4.2	11.5	10.0	3.8	10.9	4.8	12.5	4.2

4.2.a.5. Effect of first order interaction between sowing rate and phosphorus fertilization levels:

Data given in Table (5) show that maximim values of a, b and total chlorophyll were obtained from plants grown under the lowest sowing rate (20 kg seeds/fad.) and received the medium level of phosphorus fertilizer, i.e. 64 kg P_2O_5/fad. in most cases. Moreover, such data revealed that carotenoids content was significantly increased by using either 20 or 30 kg seeds/fad. within 64 kg P_2O_5/fad. These results were the same at both seasons of this work.

4.2.a.6. Effect of first order interaction between nitrogen and phasphorus fertilization levels:

It is evident from data presented in Table (5) that the effect of interaction between nitrogen and phosphorus fertilization on a, b and total chlorophyll as well as carotenoids contents was statistically significant but the response of the photosynthetic pigments except the carotenoids was not constant at the two seasons of growth. The highest values of photosynthetic pigments were mostly obtained by application of 30-60 kg N combined with 64-96 kg P_2O_5/fad.

This means that increasing both N and P fertilizers level significantly increased a, b and total chlorophyll and carotenoids content of plant leaves. Similar findings were demonstrated by El-Abedeen *et al.* (1983), El-Afifi and Darweesh (1990) and Radoglou and Jarvis (1992) on beans who reported that photosynthetic pigments content in leaves was enhanced after fertilization with 20 or 40 kg N and 18 or 36 kg P_2O_5/fad. Moreover, Abaza (1991) on bean found that chlorophyll a was not affected by NPK fertilization, meanwhile, chlorophll b and total chlorophyll content was increased.

4.2.a.7. Effect of second order interaction among sowing rate and nitrogen and phosphorus fertilization levels.

Results shown in Table (6) illustrate that, using 20 kg seeds/fad. combined with 60 kg N and 32 kg P_2O_5/fad. or using 40 kg seeds/fad. with 90 kg N and 32 kg P_2O_5/fad. in the first season resulted in mostly the highest values of photosynthetic pigments. However, the significantly highest values in the second season in most cases were obtained by using 20 kg seeds/fad. within 60 kg N and 64 kg P_2O_5/fad. It can be stated, in general, that seed sowing rate at 20 kg seeds/fad. combined with fertilization by 60-90 kg N and 32-64 kg P_2O_5/fad. resulted in the highest values in this respect.

Concerning the effect of interaction among sowing rate, nitrogen and phosphorus fertilization level, Abaza (1991) on *Phaseolus vulgaris* found that chlorophyll a and b were not affected by this interaction, however, total chloroplyll was inceased as a result of this tri-interactions under different both plant density and NPK fertilizers level.

4.2.b. Total N, P and K concentration and uptake/plant leaves:

4.2.b.1. Effect of sowing rate:

With regard to the effect of sowing rate on mineral content of bean plant leaves, the data presented in Table (7) generally, show that sowing rate seemed to be effective on the concentration of N, P and K as well as their total uptake in plant leaves.

It is obvious from the aforementioned results that 20 kg seeds/fad. gave the highest values of the N, P, K content as concentration or uptake in most cases except N concentration in the second season which behaved differently.

Such results may be attributed to the low competition between plants that have the chance for absorbing more quantities of minerals. Furthermore, obtained results may suggest that the

Table (6): Effect of second order interaction among sowing rate, nitrogen and phosphorus fertilization level on the photosynthetic pigments content (mg/100 g D.W.) of common bean plant leaves.

Characters / Treatments			1992				1993			
			Chlorophyll			Carot-enoids	Chlorophyll			Carot-enoids
			a	b	Total a + b		a	b	Total a + b	
Ferti. level N	P_2O_5	sow. rate kg/fad.	Effect of sow.rate X N X P-levels							
		20	318.6	110.5	429.1	190.0	342.3	248.0	590.3	157.8
	32	30	295.9	168.1	464.0	167.2	385.2	230.2	615.4	176.9
		40	317.1	144.7	461.8	186.1	364.0	203.6	567.6	181.1
		20	337.0	172.3	509.3	175.8	395.8	240.5	636.3	236.2
30	64	30	420.2	160.6	580.8	228.2	390.9	221.9	612.8	187.2
		40	238.0	150.9	388.9	229.1	410.4	188.4	598.8	277.4
		20	297.5	168.0	465.5	164.2	362.5	146.5	509.0	177.5
	96	30	422.0	227.6	649.6	258.6	358.2	172.0	530.2	205.2
		40	446.9	213.7	660.6	224.2	416.9	153.1	570.0	236.4
		20	323.1	139.1	462.2	176.6	337.9	138.1	476.0	226.8
	32	30	374.6	165.6	540.2	179.0	405.6	250.7	656.3	148.4
		40	487.5	244.5	732.0	259.4	341.8	143.5	485.3	168.7
		20	457.3	243.5	700.8	277.0	502.5	324.1	826.6	303.2
60	64	30	329.7	154.8	484.5	200.7	441.0	178.1	619.1	276.6
		40	340.6	124.4	465.0	198.3	407.6	124.1	531.7	189.5
		20	396.3	135.0	531.3	181.0	454.6	144.6	599.2	206.3
	96	30	318.0	109.3	427.3	186.0	437.9	174.8	612.7	182.0
		40	298.0	155.9	453.9	161.2	344.3	147.8	492.1	155.7
		20	444.4	234.8	679.2	256.3	487.2	279.7	766.9	215.6
	32	30	305.9	172.4	478.4	147.3	410.4	147.2	557.6	229.4
		40	255.9	183.6	439.5	176.3	441.7	146.3	588.0	191.1
		20	445.3	227.7	673.0	213.2	504.1	294.1	798.2	147.0
90	64	30	425.5	152.6	578.1	248.4	449.8	130.0	579.8	230.7
		40	327.6	171.5	499.1	177.9	344.0	162.7	506.7	179.0
		20	290.9	194.5	485.4	228.7	501.8	343.3	845.1	178.0
	96	30	276.1	164.3	440.4	185.4	418.8	130.6	549.4	174.8
		40	315.0	153.8	468.8	181.2	345.2	132.1	477.3	148.8
L.S.D. at 0.05			7.3	19.9	17.3	6.7	19.0	8.3	21.7	7.3

Table (7): Effect of sowing rate, nitrogen or phosphorus fertilization level on the minerals content of common bean plant leaves.

Characters / Treatments	1992						1993					
	Minerals (mg/100 g D.W.)			Minerals uptake (mg/plant leaves)			Minerals (mg/100 g D.W.)			Minerals uptake (mg/plant leaves)		
	N	P	K	N	P	K	N	P	K	N	P	K
Effect of sowing rate												
kg seed /fad.												
20	2736	544	4515	157	31	258	3178	561	4620	251	45	362
30	2668	521	4311	130	25	210	3298	538	4536	240	39	329
40	2581	533	4179	118	24	191	3307	550	4595	247	41	348
L.S.D. at 0.05	22	1	54	1	0.3	0.3	19	3	N.S.	1	0.4	1
Effect of N-level												
Kg N/fad.												
30	2681	528	4341	127	25	209	3251	555	4632	217	38	308
60	2622	545	4434	136	28	226	3325	551	4619	306	50	428
90	2682	526	4230	141	28	224	3207	544	4550	214	37	303
L.S.D. at 0.05	N.S.	2	52	0.3	0.3	0.4	22	2	38	0.3	0.4	0.3
Effect of P-level												
Kg P_2O_5/fad.												
32	2602	525	4352	111	22	186	3228	547	4654	218	37	315
64	2688	526	4240	136	27	213	3195	543	4708	233	40	347
96	2694	547	4413	158	32	260	3360	560	4439	286	48	377
L.S.D. at 0.05	22	3	33	0.3	0.2	0.3	21	2	34	0.3	0.3	0.3

contents of N, P and K, generally, followed the same trend of growth rate (Table 1) under the low sowing rate (20 kg seeds/fad). These results are confirmed by those of Mafra *et al.* (1974), Mack (1983) and El-Afifi and Darweesh (1990) on beans who found that lower plant stand increased the concentration of nitrogen, phosphorus and potassium in plant leaves. On the other hand, contra results were reported by Abaza (1991) on bean and Ahlawat and Saraf (1983) on pea who indicated that higher plant population increased N, P and K as concentraion and uptake. Moreover, Morsy (1986) on cowpea showed that medium plant spacing increased the N, P and K uptake. Meanwhile, El-Bakry (1966) and Cyril (1980) on bean demonstrated that plant density had no effect on the concentration of nitrogen, phosphorus and potassium in plant leaves.

4.2.b.2. Effect of nitrogen fertilization level:

Data tabulated in Table (7) show that the highest increments regarding leaves content of N, P and K as concentration and uptake in most cases were observed by increasing nitrogen fertilizer level up to 60 kg N/fad. at both growing seasons except nitrogen in the first season which concentration was not significantly affected but its uptake was increased with increasing N-level up to 90 kg N/fad. The enhancing effect of nitrogen fertilizer in this concern may be due to the available nitrogen in soil and/or the high absorbing efficiency of bean roots. These results are in agreement with those of El-Bakry *et al.* (1980), Mack (1983) and Farag *et al.* (1987) on beans who indicated that nitrogen, phosphorus and potassium percentage and uptake increased by increasing nitrogen level. Similar results were also obtained by Morsy (1986) and Khalil (1990) on cowpea, El-Beheidi *et al.* (1984) on pea and Fang *et al.* (1989) on broad bean.

However, contra findings were obtained by El-Bakry (1966) and Chui (1985) on bean who indicated that N-application did not affect N, P and K concentration and uptake. Moreover, Cyril (1980), Lluch *et al.* (1983 and Smithson *et al.* (1993) on beans

reported that nitrogen fertilization reduced phosphorus and potassium concentration and uptake.

4.2.b.3. Effect of phosphorus fertilization level:

Data given in Table (7) reveal that the maximum concentrations and uptake of N, P and K were obtained by application of phosphorus fertilizer at its highest used level (96 kg P_2O_5/fad.) These results are the same at both seasons of this work except the concentration of potassium in the second season, which showed the highest values in this respect with the medium used level of P-fertilizer (64kg P_2O_5/fad).

These results coincide with those obtained by El-Bakry *et al.* (1980), Ssali and Keya (1983), Jonathan *et al.* (1991) and Browaldh (1992) on beans who showed that phosphorus fertilizers had a positive effect on the concentration and uptake of nitrogen and phosphorus in the plant tissues. In this concern, similar results were also obtained by Midan and Malash (1982), El-Sawah *et al.* (1985), Kothari and Saraf (1986), Farag *et al.* (1987), El-Mansi *et al.* (1991) and Purushothaman *et al.* (1991) on different legume crops who found that nitrogen, phosphorus and potassium concentrations and their uptake per plant were increased by increasing phosphorus application. On the other hand, contra results were demonstrated by Cyril (1980) on bean and Walker *et al.* (1985) on soyabean who found that N, P and K concentrations were decreased by phosphorus application.

4.2.b.4. Effect of first order interation between sowing rate and nitrogen fertilization level:

Data presented in Table (8) clearly indicate that the concentrations of N, P and K and their uptake were significantly affected by the interaction between sowing rate and nitrogen fertilizer level in both seasons of growth. It is obvious from such data that using 20 kg seeds/fad. Within application of 60 or 90 kg N/fad. mostly showed the highest values in this respect. In general,

Table (8): Effect of first order interaction between sowing rate and/or nitrogen and phosphorus fertilization level on the minerals content of common bean plant leaves.

Characters / Treatments	1992						1993					
	Minerals (mg/100 g D.W.)			Minerals uptake (mg/plant leaves)			Minerals (mg/100 g D.W.)			Minerals uptake (mg/plant leaves)		
	N	P	K	N	P	K	N	P	K	N	P	K
Effect of sow.rate X N-level												
N sow.rate kg/fad.												
20	2817	533	4418	22	157	249	3200	565	4807	22	49	394
30 30	2779	520	4234	21	114	172	3307	549	4732	24	22	179
40	2409	530	4370	19	110	207	3246	550	4356	22	43	351
20	2627	553	4601	21	152	261	3430	578	4390	24	57	440
60 30	2656	530	4362	20	125	205	3312	534	4701	22	51	456
40	2659	551	4340	21	131	211	3233	540	4765	24	44	387
20	2764	545	4525	21	161	263	2903	541	4662	22	29	250
90 30	2569	514	4335	22	150	253	3274	532	4325	24	45	352
40	2676	519	3827	21	111	155	3442	558	4662	22	36	306
L.S.D. at 0.05	47	3	89	1	1	1	38	3	66	1	1	1
Effect of sow.rate X P-level												
P_2O_5 sow.rate kg/fad.												
20	2597	536	4654	21	110	197	3233	554	4932	23	34	292
32 30	2618	521	4301	20	120	198	3101	539	4304	23	38	301
40	2592	518	4100	20	102	162	3349	547	4726	22	39	352
20	2841	531	4423	22	167	263	3218	551	4392	23	40	317
64 30	2620	501	4314	19	123	202	3214	527	4871	24	37	356
40	2604	546	3983	20	117	175	3151	551	4861	24	42	367
20	2771	564	4467	22	193	313	3082	579	4535	22	50	476
96 30	2766	542	4316	22	146	230	3578	549	4583	23	42	330
40	2547	536	4454	22	134	236	3421	551	4196	23	42	325
L.S.D. at 0.05	37	4	56	1		1	36	3	58	1	1	1
Effect of N X P-levels												
N P_2O_5 kg/fad.												
32	2630	503	4225	21	94	156	3419	534	4744	23	30	267
30 64	2658	524	4358	18	118	194	3039	557	4447	22	35	279
96	2717	557	4438	22	169	278	3294	574	4704	24	49	378
32	2653	545	4681	18	98	173	3188	552	4684	23	40	356
60 64	2709	541	4258	23	150	230	3280	563	4888	25	53	456
96	2579	548	4363	22	161	275	3508	538	4283	22	58	472
32	2523	528	4148	21	140	228	3077	555	4534	22	41	322
90 64	2698	513	4103	21	139	216	3264	508	4787	23	32	305
96	2788	537	4436	22	143	227	3279	568	4327	23	36	282
L.S.D. at 0.05	37	4	56	1	0.4	1	36	3	58	1	1	1

it could be suggested that bean plants grown at suitable rate of sowing seeds with sufficient soil nitrogen, contained high minerals (N, P and K) concentrations and uptake in turn, responsible of due to the high content of dry matter in plants of such treatment as shown in Table (2). Contra results were reported by Morsy (1986) on cowpea who noticed that there was no interactional effect between plant spacing up to 40 cm and nitrogen fertilizer from O up to 150 kg calcium nitrate/fad. in this respect.

4.2.b.5. Effect of first order interaction between sowing rate and phosphorus fertilization level:

Data illustrated in Table (8) show the effect of sowing rate and phosphorus fertilization level on the concentration of N, P and K as well as their uptake in bean plant leaves. Such data revealed that using 20 kg seeds/fad. and application of 96 kg P_2O_5/fad. produced mostly the highest values of N and P concentrations and uptake in plant leaves. Moreover, the increment of potassium concentration and uptake resulted from using 20 kg seeds/fad. combined with 32 or 96 kg P_2O_5/fad. It is worthy to notice that similar trend was observed in most cases during both growing seasons.

4.2.b.6. Effect of first order interaction between nitrogen and phosphorus fertilization levels:

Data shown in Table (8) reveal that the treament of application of 60 kg N combined with 96 kg P_2O_5/fad. resulted in the highest values of N, P and K concentrations in leaves. Meanwhile, 60 or 90 kg N in combintion with 64 or 96 kg P_2O_5/fad. produced the maximum values of N, P and K uptake in plant leaves. These results were mostly the same at both seasons of this work. These results are in accordance with those reported by Ssali and Keya (1986), El-Afifi and Darweesh (1990), Srinivas and Naik (1990), Abaza (1991) and Abou El-Hassan *et al.* (1993) on bean who reported that nitrogen, phosphorus and potassium fertilizers increased N, P and K percentage and uptake. Contra results were showed by Cyril (1980) on bean who found that N, P

and K concentrations were not affected by NPK fertilizer treatments. Furthermore, El-Bakry *et al.* (1980) on bean noticed that nitrogen and phosphorus fertilizers depressed P percentage in leaves. However, Mack (1983) on bean indicated that higher fertilizer rates had no consistant effect on leaves P content.

4.2.b.7. Effect of second order interaction among sowing rate, nitrogen and phosphorus fertilization levels:

Data reported in Table (9) show the effect of tri-interaction between sowing rate, nitrogen and phosphorus fertilization level on N, P and K concentrations and their uptake in plant leaves. It is obvious from such data that using 20 kg seeds/fad. and application of 30 or 60 kg N/fad. and 96 kg P_2O_5/fad. for bean plants resulted mostly in the highest values of N, P and K concentrations as well as their uptake in plant leaves. These results were of the same trend at both growing seasons.

In this concern, contra results were obtained by Mack (1983) and Abaza (1991) on bean who reported that there were no significant interaction between plant spacing and fertilizers treatments on leaf nutrient concentration.

4.3. Dry seed yield and its components:

Data presented in Table (10) show the main effect of sowing rate, nitrogen or phosphorus fertilizer. Moreover, the effect of first order interaction between sowing rate and nitrogen or phosphorus fertilizer level and nitrogen and phosphorus fetilizers level are presented in (Table 11), whileas, the tri-interaction between all of the main factors are illustrated in (Table 12).

4.3.1. Effect of sowing rate:

Data shown in Table (10) indicate that increasing quantity of seeds used per faddan, i.e. 20, 30 and 40 kg significantly and gradually decreased the values of each of number of pods/plant, number of seeds/pod, seed index, netting percentage and dry seed

Table (9): Effect of second order interaction among sowing rate, nitrogen and phosphorus fertilization level on the minerals content of common bean plant leaves.

Characters			1992						1993					
			Minerals (mg/100 g D.W.)			Minerals uptake (mg/plant leaves)			Minerals (mg/100 g D.W.)			Minerals uptake (mg/plant leaves)		
Treatments			N	P	K	N	P	K	N	P	K	N	P	K
Ferti. level N	P_2O_5	sow. rate kg/fad.	Effect of sow.rate X N X P-levels											
		20	2357	504	3900	85	18	140	3323	511	5280	202	31	315
	32	30	2823	503	4266	109	19	165	3420	536	4460	120	19	153
		40	2710	500	4510	89	17	162	3513	553	4493	260	41	332
		20	3145	513	4570	169	28	253	3397	557	4706	239	39	326
30	64	30	2633	504	4246	92	18	149	2840	549	4370	99	20	153
		40	2197	554	4260	93	24	182	2880	566	4266	230	45	359
		20	2950	580	4786	218	43	354	2880	627	4436	353	77	540
	96	30	2880	553	4190	139	27	202	3660	562	5366	171	27	233
		40	2320	536	4340	149	33	277	3343	531	4310	281	43	362
		20	2713	567	5296	98	21	192	3507	594	4310	259	44	324
	32	30	2640	518	4480	97	18	164	2933	527	4323	213	38	329
		40	2607	550	4266	98	21	164	3123	535	5420	229	38	415
		20	2740	543	4410	185	37	296	3317	585	4280	321	56	412
60	64	30	2687	516	4186	130	26	198	3397	548	5490	344	56	556
		40	2700	563	4180	134	27	195	3127	554	4896	249	47	398
		20	2427	548	4096	173	39	296	3467	555	4580	428	69	585
	96	30	2640	556	4420	150	32	253	3607	527	4290	409	59	483
		40	2670	541	4573	160	32	274	3450	531	3980	301	46	348
		20	2720	536	4766	147	29	257	2870	558	5206	137	27	236
	32	30	2390	542	4156	153	34	266	2950	554	4130	302	57	423
		40	2460	504	3523	119	24	160	3410	554	4266	242	39	307
		20	2637	536	4290	149	30	242	2940	509	4190	149	26	212
90	64	30	2540	483	4510	146	28	259	3407	483	4753	250	36	358
		40	2917	521	3510	124	23	148	3447	531	5420	216	34	345
		20	2937	563	4520	188	36	289	2900	555	4590	174	33	303
	96	30	2777	517	4340	150	28	234	3467	559	4093	248	40	276
		40	2650	531	4450	92	18	157	3470	589	4300	212	36	267
L.S.D. at 0.05			64	8	98	1	1	1	62	5	101	1	1	1

Table (10): Effect of sowing rate, nitrogen and phosphorus fertilization level on the dry seed yield and its components of common bean plants.

Characters / Treatments	1992						1993					
	No. of pods/ plant	No. of seeds/ pod	Seed index (g)	Nett-ing perce-ntage	Dry seed yield/ plant (g)	Dry seed yield (kg/ fad.)	No. of pods/ plant	No. of seeds/ pod	Seed index (g)	Nett-ing perce-ntage	Dry seed yield/ plant (g)	Dry seed yield(kg/ fad.)
kg seed /fad.	**Effect of sowing rate**											
20	8.1	3.7	29.6	66.2	8.9	559	10.7	3.5	40.2	66.8	15.1	778
30	6.8	3.7	28.1	58.8	7.0	669	9.1	3.3	38.3	60.4	11.5	897
40	5.8	3.7	26.6	57.7	5.7	760	7.9	3.2	37.1	61.0	9.4	961
L.S.D. at 0.05	0.4	N.S.	0.2	0.6	0.4	5.6	0.2	0.1	0.3	0.6	0.3	1.4
kg N/fad.	**Effect of N-level**											
30	6.5	3.6	28.6	64.6	6.8	627	6.8	3.2	37.5	64.4	8.2	592
60	7.1	3.7	28.0	60.9	7.5	689	9.4	3.2	37.1	63.9	11.2	826
90	7.1	3.7	27.7	57.2	7.4	672	11.4	3.5	41.0	60.0	16.4	1218
L.S.D. at 0.05	0.2	0.1	0.5	0.5	0.4	5.4	0.2	0.1	0.5	0.3	0.5	2.3
kg P_2O_5/fad.	**Effect of P-level**											
32	6.7	3.8	28.4	62.2	7.2	673	8.3	3.4	38.8	62.7	10.9	812
64	6.9	3.7	27.7	61.5	7.1	627	9.5	3.3	38.5	62.6	12.0	893
96	7.1	3.7	28.3	59.0	7.4	688	9.9	3.3	38.4	62.9	12.5	930
L.S.D. at 0.05	0.2	0.04	0.3	0.6	0.3	4.9	0.2	0.03	0.3	0.3	0.3	1.4

yield/plant. However, number of seeds/pod in the first season only did not show significant variations

With regard to the effect of sowing rate on dry seed yield/fad., the same data show clearly that increasing sowing rate constantly and significantly increased dry seed yield/fad. Obtained results are going in the same trend at both growing seasons.

Obtained results of the yield components and dry seed yield/plant are expected where plants grown at lower density are of low plant population/m^2 which permits wider area per plant. Such conditions permitted favourable plant supply with water, nutrients and light energy which, in turn, resulted in higher values of dry seed yield. Meanwhile, the results showing that the highest plant density resulted in the highest dry seed yield per faddan are also logical and expected since such treatments had the highest number of plants per unit area.

Concerning the effect of sowing rate on number of pods/plant, obtained results are in agreement with those reported by Gad El-Hak and Mahmoud (1988) and Abaza (1991) working on bean who found that increasing plant density decreased number of pods/plant. Moreover, similar results were also reported by Mahmoud and Gad El-Hak (1988) and Farrag (1991) on cowpea, Bakry *et al.* (1984) on peas and Stringi *et al.* (1988) and Amer *et al.* (1992) on *Vicia faba* who concluded that number of pods/plant was the most sensitive parameter which decreased by increasing plant density. Obtained results are also confirmed by those reported by Salih (1983) on faba bean and Pawlowski *et al.* (1990) on soybean who showed that increasing sowing rate decreased number of pods/plant. However, obtained results disagree with those noticed by shafik *et al.* (1988) on *Vicia faba* who stated that row spacing was not effective on number of pods/plant.

With regard to number of seeds per pod, Gad-El-Hak and Mahmoud (1988) on bean and Farrag (1991) on cowpea reported similar results to those obtained in this work where number of seeds/pod was decreased by increasing planting rate and also with those of Abul-Naas *et al.* (1986) on soybean who indicated that increasing distance between plants increased number of seeds/pod. Howerver, results obtained in this work did not agree with those found by Pastucha (1992) on *Phaseolus vulgaris* who indicated that number of seeds/pod was slightly higher at wider row spacing than at narrower one. Moreover, contra results were also obtained by Abaza (1991) on bean, Morsy (1986) on cowpea, shafik *et al.* (1988) on *Vicia faba* and Salih (1983) on faba bean who demonstrated that increasing each of plant density, plant spacing and sowing rate, respectively did not affect number of seeds/pod.

Concerning the weight of 100-seeds (seed index), Pastucha (1992) on *Phaseolus vulgaris*, Stringi *et al.* (1988) on *Vicia faba* and Pawlowski *et al.* (1990) on soybean noticed similar results to those obtained in this work where seed index was decreased by decreasing row spacing in the first work, increasing plant density in the second one and with increasing sowing rate in the last work. However, obtained results were not in confirmity with those reported by Abaza (1991) on bean, Abul-Naas *et al.* (1986) on soybean, Farrag (1991) on cowpea and Amer *et al.* (1992) on faba bean concerning plant density. Furthermore, Salih (1983) working on the effect of sowing rate of faba bean, Saleh *et al.* (1980) and Morsy (1986) all working on cowpea and Shafik *et al.* (1988) on *Vicia faba* dealing with the effect of either plant or row spacing reported contra results where they found that weight of 100-seeds was not affected in this respect.

With regard to dry seed yield per plant, obtained results are going in agreement with those reported by Arias (1980) and Pastucha (1992) on *Phaseolus vulgaris* who found that dry seed yield/ plant was increased by increasing plant spacing. Moreover, Saleh *et al.* (1980), Abul-Nass *et al.* (1986), Morsy (1986) and Lin

et al. (1991) on different legume crops demonstrated similar results to the findings of this trial concerning plant spacing. Furthermore, Salem and El-Massri (1986), Nigem *et al.* (1988-b) and Amer *et al.* (1992) on *Vicia faba* agreed with the findings of this trial where dry seed yield/plant was significantly higher under the lowest plant population.

Concerning dry seed yield per unit area, obtained results are in harmony with those reported by Mack (1983), Chang (1984), El-Afifi and Darweesh (1990) and Abaza (1991) all working on bean who found that increasing plant population increased dry seed yield per unit area. Moreover, similar results were also reported by Farrag (1991), Moore (1991), Amer *et al.* (1992), Ikeda (1992) and Weles (1993) on different legume crops concerning the effect of plant population in this respect. Obteined results are also in agreement with the findings of Salih (1983) on *Vicia faba* and Pawlowski *et al.* (1990) on soybean who found that dry seed yield increased by increasing the quantity of seeds sown in hectar. However, contra results were reported by Cyril (1980) on bean who stated that dry seed yield was lower with higher plant density and also with those of Ablett *et al.* (1991) on soybean who found that dry seed yield decreased with increasing sowing rate. In this respect, the results reported by Schans *et al.* (1991) on peas and field beans concerning plant stand Brian *et al.* (1981) on bean, Ziolek and Ziolek (1988) on *Vicia faba* and Shekhar and Sharma (1991) on peas concerning distance either between plants or rows are not in agreement with the findings of this work.

4.3.2. Effect of nitrogen fertilization level:

Data shown in Table (10) reveal that most studied characteristics of yield and its components were significantly affected by the levels of nitrogen fertilizer. Such effect was clear and going in the same trend in most cases in both seasons of this work. It is evident from such data that increasing level of nitrogen fertilizer from 30 to 60 kg N/fad. in the first season and up to the 90 kg N/fad. in the second season was of significant increasing

effect in this respect. It is also obvious that the highest yield either per plant or per Faddan was obtained as a result of using 60 or 90 kg N/fad. Such results showing that higher used levels (60 and 90 kg N/fad.) produced the highest values of different studied characteristics of plant seed yield and its components as well as dry seed yield per faddan may be explained on the base that plants growing under such conditions are supplied with adequate nitrogen fertilizer level for plant growth (Table 1) which resulted in the highest photosynthetic pigments in plant leaves (Table 4) and the highest leaves minerals content (Table 7). Hence, such vigorous growth, good nutritional plant status and higher photosynthetic pigments content resulted in turn in increasing number of flowers per plant and to the amount of metabolites synthesized by the plant. The increase in total dry seed yield owe directly to the increase in both number of pods and weight of seeds/plant.

Concerning the effect of nitrogen fertilization level on number of pods/plant, results of this work were supported by those of Emara (1985), Gligorevic (1986) and Mehar and Singh (1990) all working on bean who reported that number of pods/plant was increased by increasing nitrogen level. Moreover, similar findings were also stated by El-Mansi *et al.* (1984), Abul-Naas *et al.* (1986), Farag *et al.* (1989), Hassan *et al.* (1989), Khalil (1990) and Farrag (1991) on different legume crops in this concern. However, contra results were reported by Chui (1985) on *Phaseolus vulgaris* and *Vigna unguiculata*, Solh *et al.* (1986) on soybean and Morsy (1986) on cowpea who found that number of pods/plant was not affected by applied nitrogen rate.

With regard to number of seeds/pod, Morsy (1986) on cowpea reported similar results where number of seeds/pod was slightly increased as nitrogen fertilizer level increased. This result may be explained on the basis that number of seeds/pod is a genetical character mainly affected by variety. However, findings obtained in this work disagree with those reported by Midan *et al.*

(1980-b) and Chui (1985) on bean and Hassan *et al.* (1989) and Farrag (1991) on cowpea who indicated that number of seeds/pod was increased by increasing nitrogen rate. Moreover, contra results were also obtained by El-Mansi *et al.* (1984) on pea and Farag *et al.* (1989) on broad bean who found that number of seeds/pod did not respond to increasing N-application.

Concerning the weight of 100-seeds (seed index), obtained results for the second season are going in agreement with those reported by Midan *et al.* (1980-b), Farag *et al.* (1987), Mehar and Singh (1990), El-oksh *et al.* (1991) and Pirani (1991) all working on bean who noticed that increasing nitrogen fertilizer level increased seed index. Furthermore, Hassan *et al.* (1989), Khalil (1990) and Farrag (1991) on cowpea and Abul-Naas *et al.* (1986) on soybean demonstrated similar results in this respect. However, the contra results of the first season of this work are in confirmity with those reported by Endo *et al.* (1988) on bean, Morsy (1986) on cowpea and Solh *et al.* (1986) on soybean who found that increasing nitrogen fertilizer level had no effect on seed index.

With regard to dry seed yield/plant, obtained results are in harmony with those noticed by Emara (1985) and Sangakhara and Marambe (1989) on bean who showed that dry seed yield/plant increased with increasing level of nitrogen fertilizer. Moreover, Abul-Naas *et al.* (1986), Morsy (1986), Farag *et al.* (1989) and Khalil (1990) on different legume crops demonstrated similar results to the findings of this trial. However, obtained results are not in confirmity with those shown by Chui (1985) on bean and cowpea who found that dry seed yield/plant was not affected with increasing the rate of nitrogen fertilizer.

Concerning dry seed yield per unit area, obtained results coincide with those of Midan *et al.* (1980-b), Araya *et al.* (1981), Newton and Robertson (1982), Emara (1985), Farag *et al.* (1987), Chui (1985), El-Asdoudi *et al.* (1989), Mehar and Singh (1990) and El-Oksh *et al.* (1991) all working on bean who found that

increasing nitrogen fertilizer increased dry seed yield per unit area. Furthermore, similar results were also mentioned by Abul-Naas *et al.* (1986), Morsy (1986), Abdel-Ghaffar (1987), Farag *et al.* (1989), Hassan *et al.* (1989), El-Waraky and Haunold (1990), Khalil (1990), Farrag (1991), Yanni *et al.* (1991), Papakosta (1992) and Hassan *et al.* (1993-b) on different legume crops. However, contra results were reported by Hungria and Neves (1987) on bean who found that dry seed yield was not increased by high N-rates. Moreover, contra results were also reported by Mundra and Maliwal (1990) on bean, Rubes (1984) on peas and Krikunets (1990) on soybean who indicated that the greatest response of dry seed yield occurred in plants given low N-rates. Furthermore, Sobral and Mello (1984) and Endo *et al.* (1988) on beans, Graham and Scott (1984) on cowpea and Solh *et al.* (1986) on soybean reported the same contra results where dry seed yield was not affected by using different N-levels.

4.3.3. Effect of phosphorus fertilization level:

Data presented in Table (10) show that most of studied yield parameters were significantly affected by phosphorus fertilizer level. Although such effect was not stable or clear in the first season where differences were not so big and no clear increments may be detected, it was clear and values of different studied parameteres were gradually, constantly and significantly increased up to the highest used level of phosphorus fertilizer, i.e. 96 kg P_2O_5/fad. in the second season. The favourable effect of phosphorus on dry seed yield of legume plants is mainly due to its effect on improving plant growth, (Ssali and Keya, 1983 on bean), photosynthesis process and plant nutritional status as shown before in Tables (1, 4 and 7). The superiority of such treament (96 kg P_2O_5/fad.) on dry seed yield either per plant or per faddan may be also attributed to its enhancing effect on plant flowering and fruit setting.

Concerning the effect of phosphorus fertilization level on number of pods/plant, Mahatanya (1980), Vieira (1986) and

Chagas *et al.* (1987) on bean reported similar results to those obtained in this work where number of pods/plant was increased by increasing phosphorus fertilizer level. Obtained results are going in agreement also with those reported by Kothari and Saraf (1986), Farag *et al.* (1987) and Hassan *et al.* (1990) on *Vigna spp* and El-Sawah *et al.* (1985) and Salem and El-Massri (1986) on *Vicia faba* in this concern. However, results reported by Mack (1983) on *Phaseolus vulgaris* disagree with the findings of this work where higher rates of phosphorus fertilizer produced slight increment in pod yield. On the other hand, Alvino *et al.* (1988) on bean indicated that number of mature pods did not increase by increasing P-levels.

With regard to number of seeds/pod, obtained results are in harmony with those found by El-Sawah *et al.* (1985) on broad bean and kothari and Saraf (1986) on *Vigna radiata* who noticed that number of seeds/pod did not show any significant variation under different phosphorus application. On the other hand, contra results were obtained by Vieira (1986) on bean and Mahboob *et al.* (1984) and Hassan *et al.* (1990) on *Vigna spp* who found that number of seeds/pod was increased by phosphorus application.

Concerning the weight of 100-seeds (seed index), the findings of this work are supported by those of Kothari and Sharaf (1986) on *Vigna radiata* who indicated that seed-index did not show any significant variation under phosphorus application. However, obtained results were not in confirmity with those reported by Farag *et al.* (1987) and Hassan *et al.* (1990) on *Vigna spp* and El-Sawah *et al.* (1985) on *Vicia faba* who mentioned that seed index was increased by increasing P_2O_5 level.

With regared to dry seed yield/plant, obtained results are going in agreement with those reported by Mahatanya (1980) on *Phaseolus vulgaris*, Farag *et al.* (1987) on cowpea and salem and El-Massri (1986) on *Vicia faba* who found that increasing P_2O_5 rate increased dry seed yield/plant.

Concerning dry seed yield per unit area, obtained results are in confirmity with those demonstrated by Mahatanya (1980), Sobral and Mello (1984), Prabhakar *et al.* (1986), Selim *et al.* (1986), Alt (1987), Chagas *et al.* (1987) and Otabbong *et al.* (1991) all working on bean who found that dry seed yield per unit area was increased by increasing phosphorus fertilizer rate. Similar trend was also reported by Mahboob *et al.* (1984), Salem and El-Massri (1986), Abdel-Ghaffar (1987), Farag *et al.* (1987), Gajanan *et al.* (1990), Hassan et al. (1990), Mallarino *et al.* (1991) Rajbdandari (1992) and Hassan *et al.* (1993-b) on different legume crops in this respect. However, contra results were noticed by El-Leboudi *et al.* (1974), Midan *et al.* (1980-b) Araujo *et al.* (1982) and Hera *et al.* (1985) on bean and Abd El-Hadi *et al.* (1984) and Shannon *et al.* (1992) on soybean who indicated that phosphorus fertilizer treatments did not influence dry seed yield.

4.3.4. Effect of first order interaction between sowing rate and nitrogen fertilization level:

The illustrated data in Table (11) demonstrate that sowing 20 kg of seeds per faddan combined with application of nitrogen fertilizer at the level of 90 kg N/fad. resulted in most cases in the highest values of number of pods/plant, weight of 100-seeds and dry seed yield/plant at both growing seasons. Such results are reasonable and expected since 90 kg N/fad. and 20 kg seeds/fad. at studying the main effect of each in this respect showed superiotrity on such parameters. Moreover, with regard to the effect of interaction between sowing rate and nitrogen fertilizer on dry seed yield/fad., the same data show that using 40 kg seeds/fad. combined with 60 kg N/fad. in the first season or with 90 kg N/fad. in the second one resulted in significantly higher dry seed yield/fad. than other used combinations. It may be stated, in general, that sowing seeds at the rate of 40 kg/fad. combined with either 60 or 90 kg N/fad. led to the highest dry seed yield per unit area.

Table (11): Effect of first order interaction between sowing rate, nitrogen and phosphorus fertilization level on the dry seed yield and its components of common bean plants.

Characters / Treatments	1992						1993					
	No. of pods/ plant	No. of seeds/ pod	Seed index (g)	Netting percentage	Dry seed yield/ plant (g)	Dry seed yield (kg/ fad.)	No. of pods/ plant	No. of seeds/ pod	Seed index (g)	Netting percentage	Dry seed yield/ plant (g)	Dry seed yield (kg/ fad.)
Effect of sow. rate X N-level												
N sow.rate kg/fad.												
20	7.0	3.5	29.7	66.7	7.3	467	8.0	3.3	39.5	66.2	10.4	532
30 30	6.4	3.8	28.3	57.9	6.8	653	6.6	3.2	37.1	58.5	7.8	597
40	5.9	3.6	27.6	69.0	5.9	760	5.9	3.0	35.7	68.6	6.3	646
20	8.4	3.8	29.1	66.6	9.3	593	10.9	3.3	38.8	67.5	14.0	721
60 30	6.8	3.7	28.2	58.9	7.1	682	9.3	3.2	36.8	61.7	11.0	836
40	6.1	3.8	26.4	57.2	6.1	794	8.1	3.1	35.6	62.5	9.0	921
20	9.0	3.7	30.0	65.1	9.9	649	13.2	3.8	42.2	66.7	21.2	1080
90 30	7.0	3.8	27.9	59.4	7.4	707	11.4	3.5	40.9	61.1	16.3	1262
40	5.4	3.6	26.0	46.4	5.1	661	9.5	3.4	40.0	51.9	12.9	1316
L.S.D. at 0.05	0.4	0.1	0.8	0.9	0.7	9.4	0.3	0.1	0.8	0.5	0.8	4.0
Effect of sow.rate X P-level												
P_2O_5 sow.rate kg/fad.												
20	7.7	3.8	29.8	66.6	8.7	563	10.1	3.5	39.6	66.8	14.0	712
32 30	6.8	3.9	27.9	58.5	7.3	701	8.2	3.5	38.8	59.2	11.2	867
40	5.7	3.8	27.4	61.5	5.9	755	6.7	3.3	37.9	62.1	8.5	857
20	8.1	3.7	28.8	66.7	8.6	553	10.9	3.4	40.4	67.2	15.1	772
64 30	6.7	3.5	28.0	58.6	6.6	637	9.1	3.2	38.1	60.5	11.2	877
40	5.8	3.5	26.3	59.0	5.3	691	8.3	3.3	36.5	60.5	10.1	1034
20	8.5	3.6	30.2	65.1	9.2	593	11.1	3.6	40.8	66.7	16.4	848
96 30	6.7	3.8	28.5	59.1	7.2	704	10.0	3.2	38.0	61.7	12.3	949
40	6.0	3.8	26.2	52.6	6.0	768	8.7	3.0	36.9	60.3	9.7	993
L.S.D. at 0.05	0.3	0.1	0.5	1.1	0.5	8.5	0.3	0.1	0.6	0.7	0.5	2.5
Effect of N X P-levels												
N P_2O_5 kg/fad.												
32	6.1	3.9	27.9	64.3	6.6	624	6.5	3.5	39.3	63.3	8.9	646
30 64	6.4	3.4	29.3	65.8	6.4	612	7.3	3.1	37.2	65.1	8.4	606
96	6.7	3.6	28.4	63.6	6.9	643	6.7	3.0	35.8	64.9	7.2	523
32	6.9	3.8	27.8	63.4	7.3	686	8.2	3.2	35.7	64.9	9.4	683
60 64	7.2	3.5	26.9	61.1	6.8	620	9.0	3.2	37.3	63.8	10.7	803
96	7.2	3.9	28.9	58.2	8.1	763	11.1	3.2	38.3	63.1	13.6	993
32	7.2	3.7	29.4	59.0	7.8	709	10.2	3.6	41.3	59.9	15.2	1108
90 64	7.1	3.8	26.9	57.4	7.3	609	12.1	3.6	40.5	59.3	17.6	1271
96	7.13	3.6	27.6	55.0	7.3	659	11.9	3.5	41.3	60.7	17.2	1274
L.S.D. at 0.05	0.3	0.1	0.5	1.1	0.5	8.5	0.3	0.1	0.6	0.7	0.5	2.5

Concerning the effect of interaction between sowing rate and nitrogen fertilization level on number of pods/plant, obtained results are in agreement with those reported by Morsy (1986) and Farrag (1991) on cowpea who found that either the widest plant spacing or low planting rate within nitrogen fertilizer increased number of pods/plant. However, contra results were obtained by Morgado (1992) on bean who indicated that there was a positive interaction between nitrogen fertilizer and increasing plant population for increasing number of pods/plant.

With regard to number of seeds/pod, obtained results are in harmony with those reported by Morsy (1986) and Farrag (1991) on cowpea who stated that there were no interaction between plant spacing or population combined with nitrogen fertilizer level in this respect.

Concerning the weight of 100-seeds (seed index), obtained results in the first season are not in agreement with those reported by Farrag (1991) on cowpea who demonstrated that there was no effect of interaction between planting rate within nitrogen application levels, in this respect

Regarding dry seed yield per plant, obtained results coincide with those reported by Morsy (1986) on cowpea who found that dry seed yield/plant increased by interaction between the widest plant spacing and higher nitrogen fertilizer level.

Concerning dry seed yield per unit area, obtained results are in confirmity with those reported by Morsy (1986) and Farrag (1991) on cowpea who showed that the intereaction between narrow spacing in the first work or number of plants/hill in the second one within nitrogen fertilizer increased dry seed yield per unit area

4.3.5. Effect of first order interaction between sowing rate and phosphorus fertiliztion level:

Data shown in Table (11) indicate that values of most studied yield components and dry seed yield were significantly affected by the combination between sowing rate and phosphorus fertilizer level. Such data demonstrate that sowing 20 kg seeds/fad. within application of 96 kg P_2O_5/fad. significantly increased plant dry seed yield and its different studied components. Obtained results are mainly attributed to the effect of the low seeds sowing rate (20 kg seeds/fad.) and the highest used level of phosphorus fertilizer (96 kg P_2O_5/fad.) each alone, since thier main effects showed the same trend. Furthermore, sowing the highest used rate of seeds/fad. (40 kg seeds/fad.) within the highest used level of phosphorus fertilizer (96 kg P_2O_5/fad.) in the first season and within 64 kg P_2O_5/fad. in the second one resulted in the highest dry seed yield/fad.

Concerning the effect of intercation between sowing rate and phosporus fertilization level on dry seed yield per plant, Salem and El-Massri (1986) on faba bean reported contra results to those obtained in this work where they found that there was no interaction between plant density and P-application rate in this respect.

With regard to dry seed yield per unit area, obtained results are supported by those reported by Mahatanya (1980) on bean who demonstrated similar results in this concern where seed yield/m^2 was greater at closer spacing especially with increasing added phosphorus fertilizer. However, findings obtained in this work disagree with those reported by Pande *et al.* (1974) on *Phaseolus vulgaris* who indicated that the highest total yield/ha was obtained at the widest interrow spacing and the highest phosphorus application level.

4.3.6. Effect of first order interaction between nitrogen and phosphorus fertilization levels:

Obtained results showing the effect of interaction between different used nitrogen and phosphorus fertilizers levels are illustrated by data presented in Table (11) which show that the different studied parameters of yield components as well as dry seed yield/plant and also per faddan are significantly affected in this respect. It is evident also that application of 60 kg N and 96 kg P_2O_5/fad. in the first season and application of 90 kg N within 64 kg P_2O_5/fad. in the second one resulted mostly in the highest values in this respect. The increasing effect of either N or P-fertilizers levels on dry seed yield of beans and its components has been explained before when the main effect of each nutrient was discussed.

Concerning the effect of interaction between nitrogen and phosphorus fertilization level on number of pods/plant and number of seeds/pod, similar results were reported by, Abaza (1991) on bean who found that number of pods/plant was increased by increasing N, P and K fertilizers levels. Moreover, Smithson *et al.* (1993) on bean and Bakry *et al.* (1984) on pea, obtained similar results in this concern where they found that both number of pods/plant and number of seeds/pod were increased by increasing NPK fertilizers. Meanwhile, Midan *et al.* (1980-b) on bean cv. Giza-3 obtained contra results which were not in confirmity with those reported in this trial where they found that there was no significant effect on number of seeds/pod as a result of the interaction between nitrogen within phosphorus fertilizer.

With regard to the weight of 100-seeds (seed index), obtained results are in agreement with those reported by Gonzalez *et al.* (1985) and Abaza (1991) on bean who found that seed index was increased by increasing N,P and K fertilizers. However, contra results were obtained by Midan *et al.* (1980-b) and Vieira (1989) on bean who noticed that seed index was not affected by nitrogen, phosphorus and potassium.

Concerning dry seed yield/plant, obtained results disagree with those mentioned by Saleh *et al.* (1980) on cowpea who found that nitrogen within phosphorus fertilizer did not affect dry seed yield/plant.

With regard to dry seed yield per unit area, obtained findings are in harmony with those reported by El-Abedeen *et al.* (1983), Gallo (1984), Gonzalez *et al.* (1985), Ssali and Keya (1986), Vieira (1989), Abaza (1991) and Abou El-Hassan *et al.* (1993) all working on bean who demonstrated that increasing N and P-fertilizers rates increased dry seed yield per unit area. Similar results were also obtained by Dhage *et al.* (1984), Novikova *et al.* (1986), Naidu and Pillai (1991) and Turkhede *et al.* (1991) on different legume crops in this respect. On the other hand, contra results were observed by Midan *et al.* (1980-b) on beans who reported that there was no significant interactive effect for nitrogen within phosphorus application on dry seed yield.

4.3.7. Effect of second order interaction among sowing rate, nitrogen and phosphorus fertilization levels:

The illustrated data in Table (12) show the effect of second order interaction between all studied factors, i.e. sowing rate, nitrogen and phosphorus fertilizers levels on dry seed yield either per plant or unit area and the plant yield components. The statistical analysis of such data show that significant differences between the combinations of studied factors are detected. Sowing 20 kg seeds/fad. within 90 kg N and 32 kg P_2O_5/fad in the first season but within 64 kg P_2O_5/fad. in the second one resulted mostly in the highest values of dry seed yield/plant and its components. With regard to the effect of such second order interaction on the dry seed yield of common bean per unit area, the same data revealed that sowing 40 kg seeds/fad. combined with 60 kg N and 96 kg P_2O_5/fad in the first season and 90 kg N-within 64 kg P_2O_5/fad. in the second one resulted in significantly higher dry seed yield/fad. of Giza-3 variety of common bean than the other

Table (12): Effect of second order interaction among sowing rate, nitrogen and phosphorus fertilization level on the dry seed yield and its components of common bean plants.

Characters / Treatments			1992 season						1993 season					
			No. of pods/ plant	No. of seeds/ pod	Seed index (g)	Nett-ing perce-ntage	Dry seed yield/ plant (g)	Dry seed yield (kg/ fad.)	No. of pods/ plant	No. of seeds/ pod	Seed index (g)	Nett-ing perce-ntage	Dry seed yield/ plant (g)	Dry seed yield (kg/ fad.)
Fert. level N	P_2O_5 kg/fad.	sow.rate	Effect of sow. rate X N X P-levels											
		20	6.4	3.8	28.5	66.9	6.9	442	7.8	3.6	40.5	66.7	11.3	576
	32	30	6.4	4.1	28.0	57.4	7.3	701	6.4	3.6	39.2	56.5	9.0	689
		40	5.6	3.7	27.3	68.5	5.7	730	5.4	3.2	38.3	66.7	6.6	673
		20	6.9	3.4	29.7	66.7	7.0	448	8.9	3.1	39.6	65.2	10.9	556
30	64	30	6.5	3.3	29.1	57.8	6.2	595	6.6	3.1	37.5	59.0	7.7	589
		40	5.9	3.6	29.0	73.0	6.2	794	6.4	3.0	34.6	71.0	6.6	673
		20	7.6	3.4	31.0	66.6	8.0	512	7.4	3.2	38.5	66.7	9.1	464
	96	30	6.4	3.9	27.8	58.7	6.9	662	6.7	2.9	34.6	60.0	6.7	513
		40	6.4	3.5	26.5	65.5	5.9	755	6.0	2.8	34.3	68.0	5.8	592
		20	7.8	3.8	29.0	66.7	8.6	550	9.7	2.9	36.3	66.9	10.2	520
	32	30	7.0	3.8	27.4	59.3	7.3	701	8.1	3.3	36.2	61.0	9.7	742
		40	6.0	3.9	27.0	64.1	6.3	806	6.8	3.3	34.5	66.7	7.7	785
		20	8.6	3.8	28.4	66.7	9.3	595	9.8	3.4	39.0	69.0	12.9	658
60	64	30	7.0	3.4	27.4	59.4	6.5	624	8.6	3.2	36.8	62.0	10.1	773
		40	5.9	3.4	25.0	57.3	5.0	640	8.6	3.1	36.0	60.3	9.6	979
		20	8.7	3.8	30.0	66.3	9.9	634	13.1	3.6	41.0	66.7	19.3	984
	96	30	6.5	3.9	29.7	58.1	7.5	720	11.2	3.1	37.5	62.1	13.0	995
		40	6.4	4.2	27.1	50.3	7.3	934	9.0	3.0	36.3	60.5	9.8	1000
		20	9.0	3.8	32.0	66.3	10.9	698	12.8	3.8	42.0	66.7	20.4	1040
	32	30	7.0	3.7	28.3	59.0	7.3	701	10.1	3.7	41.0	60.0	15.3	1171
		40	5.5	3.7	27.9	51.8	5.7	730	7.8	3.4	41.0	53.0	10.8	1112
		20	8.9	3.8	28.3	66.7	9.6	614	14.1	3.6	42.5	66.7	21.6	1102
90	64	30	6.7	3.9	27.4	58.7	7.2	691	12.2	3.4	40.0	60.3	16.5	1262
		40	5.6	3.6	25.0	46.8	5.0	640	9.9	3.7	39.0	50.2	14.2	1448
		20	9.2	3.6	29.8	62.5	9.9	634	12.8	4.0	42.0	66.7	21.5	1097
	96	30	7.3	3.7	28.0	60.5	7.6	730	12.0	3.5	41.8	63.0	17.5	1339
		40	5.3	3.6	25.0	42.2	4.8	614	11.0	3.1	40.0	52.4	13.6	1387
L.S.D. at 0.05			0.5	0.1	0.8	1.8	0.9	15.0	0.5	0.1	1.0	1.1	0.9	15.0

used combinations. These findings are explained on the base that 40 kg seeds/fad. in both seasons and 60 kg N-within 96 kg P_2O_5/fad. in the second season showed the most favourable effect in this respect when they were studied each alone or in combinations for each two factors togather. The variable response of dry seed yield/plant or per faddan as well as the yield components in both the two seasons in this work where the best combination in the first season was not the same as in the second one which may be attributed to the variation in number of seeds/g of the sown seeds in the two growing seasons as shown in the table clearing this point in the materials and methods. Finally, it may be concluded that sowing 40 kg seeds/fad. from the variety Giza-3 of common bean and fertilizing plants with 60 to 90 kg N/fad. as ammonium nitrate and 64 to 96 kg P_2O_5/fad. as calcium superphosphate with the application of 100 kg potassium sulphate led to the highest production of dry seed yield/fad.

Concerning the effect of second order interaction among sowing rate, nitrogen and phosphorus fertilization levels on both number of pods/plant and seeds/pod and weight of 100-seeds (seed index), obtained results are in harmony with those reported by Bakry *et al.* (1984) on pea who found that the medium and lowest plant density within NPK fertilizers increased number of pod/plant and number of seeds/pod. In this respect, Saleh *et al.* (1980) on cowpea found that maximum value of seed index was obtained from wide plant spacing and higher NPK fertilization level. However, obtained results disagree with those noticed by Abaza (1991) on bean who found that dry seed components, i.e. number of pods/plant, number of seeds/pod and seed index were not affected by the interation between plant density and NPK fertilizers treatments.

With regard to dry seed yield per unit area, Mauro and Vieira (1975) and Abaza (1991) on bean, Bakry *et al.* (1984) and Ferrari *et al.* (1992) on pea and Abul-Naas *et al.* (1986) on soybean reported similar results to those obtained in this work

Table (13): Effect of sowing rate, nitrogen or phosphorus fertilization level on the minerals content (mg/100 g D.W.) of common bean seeds.

Characters / Treatments	1992			1993		
	N	P	K	N	P	K
kg seed/fad.	**Effect of sowing rate**					
20	3400	565	2772	3614	607	2654
30	3354	612	2814	3734	609	2754
40	3248	589	2812	3623	617	2703
L.S.D. at 0.05	30	9	33	25	3	15
Kg N/fad.	**Effect of N-level**					
30	3262	589	2893	3628	612	2701
60	3328	598	2776	3721	615	2701
90	3413	580	2731	3621	606	2710
L.S.D. at 0.05	37	7	23	14	7	N.S.
Kg P_2O_5/fad.	**Effect of P-level**					
32	3209	592	2783	3583	612	2667
64	3297	562	2827	3739	618	2733
96	3496	613	2789	3649	603	2712
L.S.D. at 0.05	27	6	20	22	7	16

bean, Rubes (1984) and El-Waraky and Haunold (1990) on peas, Andrews *et al.* (1986) on *Vicia faba*, Khalil (1990) on cowpea and Yanni *et al.* (1991) on soybean who reported that increasing nitrogen fertilizer rate increased N-percent and uptake. Furthermore, El-Bakry *et al.* (1980) on bean and Dhage *et al.* (1984) on *Vigna mungo* showed that N-application increased P-content of seeds. Contra results were noticed by Moraghan *et al.* (1991) on bean who found that application of N-fertilizer had little effect on grain N-concentration.

4.4.a.3. Effect of phosphorus fertilization level:

Data in Table (13) show that the concentration of N, P and K were markedly affected by phosphorus fertilization level. Such data showed that using 64 or 96 kg P_2O_5/fad. were the most effective levels which resulted in the highest values of N, P and K dry seeds content in both growing seasons. Obtained results are in confirmity with those reported by Aulakh and Pasricha (1977) and Peck *et al.* (1980) on bean, Abd El-Hadi *et al.* (1984) on soybean, Dhage *et al.* (1984) on *Vigna mungo* and Farrag *et al.* (1992) on broad bean. However, contra results were demonstrated by Vieira (1986) on bean who found that increasing phosphorus application decreased N-seed content. Meanwhile, obtained results disagreed with those reported by Soliman and Farah (1985) on soyabean who found that phosphorus application did not affect N-seed content.

4.4.a.4. Effect of first order interaction between sowing rate and nitrogen fertilization level:

The illustrated data in Table (14) show that there was statistically significant effect in this respect at both seasons of growth except phosphorus concentration in the first season which values were not significantly varied. It is clearly evident from such data that using 20-30 kg seeds/fad. within application of 30 kg N/fad. mostly showed the highest values of P and K concentrat-ions. Moreover, the combination between 30 kg seeds/fad. and 90

Table (14): Effect of first order interaction between sowing rate and/or nitrogen and phosphorus fertilization level on the minerals content (mg/100 g D.W.) of common bean plant leaves.

Characters / Treatments		1992			1993		
		N	P	K	N	P	K
Effect of sow. rate X N-level							
N	sow.rate kg/fad.						
	20	3447	563	3010	3539	626	2657
30	30	3354	611	2884	3829	583	2775
	40	2986	591	2783	3517	627	2671
	20	3357	577	2773	3819	603	2723
60	30	3234	620	2732	3558	636	2704
	40	3392	596	2821	3787	607	2674
	20	3397	555	2533	3484	592	2582
90	30	3474	605	2826	3814	607	2782
	40	3367	581	2832	3566	618	2764
L.S.D. at 0.05		64	N.S.	40	24	12	33
Effect of sow.rate X P-level							
P_2O_5	sow.rate kg/fad.						
	20	3320	563	2736	3624	616	2658
32	30	3203	628	2784	3684	611	2748
	40	3104	583	2826	3441	608	2593
	20	3411	546	2802	3657	618	2676
64	30	3331	574	2835	3797	618	2787
	40	3149	565	2844	3762	619	2734
	20	3469	586	2777	3561	588	2627
96	30	3529	634	2823	3719	597	2725
	40	3491	620	2765	3666	625	2782
L.S.D. at 0.05		47	10	35	38	12	27
Effect of N X P-levels							
N	P_2O_5 kg/fad.						
	32	3371	602	2944	3589	603	2733
30	64	2873	552	2927	3470	617	2698
	96	3542	612	2805	3826	616	2672
	32	2883	582	2725	3644	605	2592
60	64	3648	579	2810	4016	631	2784
	96	3452	632	2791	3503	610	2725
	32	3373	591	2677	3517	627	2675
90	64	3370	554	2744	3731	607	2715
	96	3494	596	2770	3617	583	2737
L.S.D. at 0.05		47	10	35	38	12	27

kg N/fad. resulted in the highest seeds N-content. Obtained results are in agreement with those showed by Morsy (1986) on cowpea who indicated that plants grown at the widest spacing and received the highest level of N-produced seeds with higher N, P and K contents.

4.4.a.5. Effect of first order interaction between sowing rate and phosphorus fertilization level:

Data shown in Table (14) reveal that sowing seeds at the rate of 30 kg seeds/fad. within 64 or 96 kg P_2O_5/fad. significantly increased, in most cases the concentrations of N, P and K in dry seeds. Similar findings were reported by Pajput *et al.* (1991) on soyabean who showed that N, P and K uptake in seeds increased by increasing phosphorus application and wide row spacing.

4.4.a.6. Effect of first order interation between nitrogen and phosphorus fertilization levels:

Data illustrated in Table (14) show that the heaviest increments in the dry seeds contents of total nitrogen, phosphorus and potassium were obtained, generally, by using 60 kg N/fad. within application of 64 kg P_2O_5/fad. in case of N and K seeds content and with 96 kg P_2O_5/fad. in case of P-content in both growing seasons. Similar results were obtained by Eid (1991) on bean, Soliman and Farah (1985) and Naidu and Pillai (1991) on soybean who stated that seed N and P concentrations were positively correlated with the applied nitrogen and phosphorus fertilizer. Moreover, obtained results were in harmony with those noticed by Saleh *et al.* (1980) on cowpea who found that seed N, P and K contents were increased slightly by increasing N, P and K fertilizers level.

4.4.a.7. Effect of second order interaction among sowing rate, nitrogen and phosphorus fertilization levels:.

Data presented in Table (15) reveal that using 40 kg seeds/fad. combined with 60 kg N/fad. and 64 kg P_2O_5/fad.

Table (15): Effect of second order interaction among sowing rate, nitrogen and phosphorus fertilization level on the minerals content (mg/100 g D.W.) of common bean plant leaves.

Characters / Treatments			1992			1993		
			N	P	K	N	P	K
Ferti. level N	Ferti. level P_2O_5	sow. rate kg/fad.	Effect of sow.rate X N X P-levels					
		20	3397	565	3030	3477	605	2666
	32	30	3377	629	2936	3710	573	2816
		40	3340	612	2866	3580	630	2716
		20	3433	549	3040	3583	631	2650
30	64	30	2927	568	2936	3617	586	2860
		40	2260	538	2806	3210	633	2586
		20	3510	575	2960	3557	642	2656
	96	30	3760	636	2780	4160	590	2650
		40	3357	623	2676	3760	617	2710
		20	3287	553	2590	4120	622	2713
	32	30	2777	628	2770	3637	632	2706
		40	2587	564	2816	3177	562	2356
		20	3557	558	2906	4000	623	2860
60	64	30	3507	577	2666	3680	640	2686
		40	3880	602	2856	4367	628	2806
		20	3227	621	2823	3337	563	2596
	96	30	3420	655	2760	3357	636	2720
		40	3710	620	2790	3817	631	2860
		20	3277	570	2590	3277	620	2596
	32	30	3457	628	2646	3707	627	2723
		40	3387	574	2796	3567	633	2706
		20	3243	531	2460	3387	599	2520
90	64	30	3560	578	2903	4095	627	2816
		40	3307	553	2870	3710	596	2810
		20	3670	563	2550	3790	558	2630
	96	30	3407	609	2930	3640	565	2806
		40	3407	615	2830	3420	626	2776
L.S.D. at 0.05			81	17	61	66	21	47

resulted in the highest N-seed content while the treatment of the combination between 30 kg seeds/fad. within 60 kg N/fad. and 96 kg P_2O_5/fad. produced seeds of higher P-content. Moreover, regarding K-dry seeds content, the same data showed that using the seed sowing rate of 20 kg seeds/fad. in combination with 30 kg N and 96 kg P_2O_5/fad. produced seeds of the highest K content. Obtained results are in harmony with Morsy (1986) on cowpea and Pajput *et al.* (1991) on soybean who found that there were enhancing effect of N and P fertilizers in this concern.

4.4.b. Reducing, non-reducing and total sugars content:

4.4.b.1. Effect of sowing rate:

Data presented in Table (16) show that a significant decrease in the percent of non-reducing and total sugars may be detected as a results of decreasing seeds sowing rate where using the lowest used rate, i.e. 20 kg seeds/fad. resulted in the highest percentage of non-reducing and total sugars in dry seeds. However, reducing sugars of seeds were not significantly affected in this respect. Similar trend was observed in both growing seasons. Such data may be due to that large area occupied by plants grown at lower plant stand could be possibly have encouraged plant growth development which supplied plants with ample nutrients which are, in turn, essential in metabolic processes.

4.4.b.2 Effect of nitrogen fertilization level:

Results shown in Table (16) illustrate that nitrogen fertilizer level seemed mostly to affect sugar fractions percent of bean seeds. Whereas, nitrogen at high level (90 kg N/fad.) in both seasons proved to be of more pronounced effect on the dry seed content of non-reducing and total sugars. However, reducing sugars content was not significantly affected in both seasons. In general, it may be stated, as an average of the two seasons of this work, that high used level of N-fertilizer (90 kg N/fad.) resulted in significantly higher values of sugars percentages. The increase in sugar fractions contents by the addition of nitrogen fertilizer is

Table (16): Effect of sowing rate, nitrogen or phosphorus fertilization level on the sugars percentage of common bean seeds.

Characters / Treatments	1992			1993		
	Reducing	Non-reducing	Total	Reducing	Non-reducing	Total
	Effect of sowing rate					
kg seed /fad.						
20	3.7	11.4	15.1	3.1	11.6	14.7
30	3.6	8.8	12.4	3.0	10.9	13.9
40	3.5	10.2	13.7	3.0	11.6	14.6
L.S.D. at 0.05	N.S.	0.3	0.2	N.S.	0.3	0.2
	Effect of N-level					
kg N/fad.						
30	3.6	9.3	12.9	3.1	11.4	14.5
60	3.6	10.4	14.0	3.1	10.6	13.7
90	3.4	10.8	14.2	3.1	11.9	15.0
L.S.D. at 0.05	N.S.	0.3	0.2	N.S.	0.4	0.2
	Effect of P-level					
kg P_2O_5/fad.						
32	3.6	10.6	14.2	3.1	10.8	13.9
64	3.6	9.1	12.7	3.1	10.4	13.5
96	3.5	10.8	14.3	3.1	12.8	15.9
L.S.D. at 0.05	0.1	0.2	0.3	N.S.	0.3	0.3

fractions contents by the addition of nitrogen fertilizer is probably due to the promoting effect of nitrogen for increasing the activity of carbohydrates hydrolizing enzymes. Obtained results are in line with those. obtained by Khalil (1990) on cowpea who found that increasing N-level increased reducing, non-reducing and total soluble sugars content in dry seeds. Similar results were obtained by El-Mansi *et al.* (1984) and Khalil (1990) on green pea seed who reported that total soluble sugars were improved by adding nitrogen.

4.4.b.3. Effect of phosphorus fertilization level:

Data presented in Table (16) reveal that non-reducing and total sugars percentage increased by using 96 kg P_2O_5/fad. in both seasons of this trial. Whereas, reducing sugars were not clearly affected in this respect. However, obtained results disagree with those reported by Kamel (1994) on cowpea who found that soluble sugars content in seeds was not affected by P-fertilizer solution.

4.4.b.4. Effect of first order interaction among sowing rate and nitrogen fertilization level:

The illustrated data in Table (17) show that the combined effect of sowing rate and nitrogen fertilization significantly affected, non-reducing and total sugars percentage in both seasons of growth. It is obvious from such data that the effect of interaction between these two factors was more pronounced mostly by using 20 kg seeds/fad. within application of nitrogen fertilizer at 30 kg N/fad. However, reducing sugars percentages were not significantly affected in this respect.

4.4.b.5. Effect of first order interaction between sowing rate and phosporus fertilization level:

Data tabulated in Table (17) show that the highest increments regarding seed content of reducing, non-reducing and total sugars percentage were observed by the interaction between sowing rate at 20 kg/fad. combined with 96 kg P_2O_5/fad. These

Table (17): Effect of first order interaction between sowing rate and/or nitrogen and phosphorus fertilization level on the sugars percentage of common bean seeds.

Characters / Treatments		1992			1993		
		Reducing	Non-reducing	Total	Reducing	Non-reducing	Total
N sow.rate kg/fad.		**Effect of sow.rate X N-level**					
	20	3.6	12.0	15.6	3.2	13.3	16.5
30	**30**	3.6	6.9	10.5	3.0	11.0	14.0
	40	3.6	9.0	12.6	3.0	11.6	14.6
	20	3.7	11.2	14.9	3.1	9.4	12.5
60	**30**	3.6	9.6	13.2	3.1	9.5	12.6
	40	3.6	10.3	13.9	2.9	12.9	15.8
	20	3.4	11.0	14.4	3.0	12.0	15.0
90	**30**	3.3	10.0	13.3	3.2	12.1	15.3
	40	3.4	11.2	14.6	3.0	10.1	13.1
L.S.D. at 0.05		N.S.	0.6	0.4	N.S.	0.6	0.4
P_2O_5 sow.rate kg/fad		**Effect of sow.rate X P-level**					
	20	3.5	10.5	14.0	3.1	9.8	12.9
32	**30**	3.5	10.8	14.3	3.0	10.4	13.4
	40	3.4	10.3	13.7	3.0	12.3	15.3
	20	3.5	9.4	12.9	3.2	11.6	14.8
64	**30**	3.5	7.7	11.2	3.1	9.0	12.1
	40	3.6	10.2	13.8	3.0	10.5	13.5
	20	3.6	14.3	17.9	3.1	13.3	16.4
96	**30**	3.4	8.0	11.4	3.2	13.1	16.3
	40	3.5	10.0	13.5	3.1	11.9	15.0
L.S.D. at 0.05		0.1	0.4	0.5	N.S.	0.5	0.4
N P2O5 kg/fad.		**Effect of N X P-levels**					
	32	3.4	8.9	12.3	3.0	9.0	12.0
30	**64**	3.7	11.5	15.2	3.2	11.9	15.1
	96	3.5	11.3	14.8	3.1	15.0	18.1
	32	3.7	9.3	13.0	3.0	10.2	13.2
60	**64**	3.6	8.5	12.1	3.2	9.9	13.1
	96	3.5	9.5	13.0	2.9	11.7	14.6
	32	3.2	9.7	12.9	2.9	13.2	16.1
90	**64**	3.4	11.1	14.5	2.9	9.3	12.2
	96	3.5	11.5	15.0	3.2	11.7	14.9
L.S.D. at 0.05		0.1	0.4	0.5	N.S.	0.5	0.4

results were the same at both seasons of this work except reducing sugars percentage in the second season which was not significantly affected.

4.4.b.6. Effect of first order interaction between nitrogen and phosphorus fertilization levels.

Results reported in Table (17) show the effect of the interaction between nitrogen and phosphorus fertilization level on non-reducing and total sugars in bean dry seeds. It is evident from such data that using 30 kg N/fad. and application of the medium or the highest used levels of phosphorus (64 and 96 kg P_2O_5/fad.) fertilizers in the first season and using 30 kg N within 96 kg P_2O_5/fad. in the second one resulted in mostly the highest values in this concern. Obtained results are expected since such levels of these fertilizers showed the most promotive effect when they were discussed each alone to show the main effect of each.

4.4.b.7. Effect of second order interaction among sowing rate, nitrogen and phosphorus fertilization levels:

Data illustrated in Table (18) show the effect of second order interaction between sowing rate within nitrogen and phosphorus fertilization level on reducing, non-reducing and total sugars percentage in bean dry seeds. Obtained results were statistically significant. Such findings were obtained by using 20 kg seeds/fad. within 60 kg N/fad. in the fist season and 30 kg N/fad. in the second one and 96 kg P_2O_5/fad. Obatined results were mostly the same in both growing seasons. Moreover, such data show clearly that using the lowest plant density (20 kg seeds/fad) combined with the highest used level of P-fertilizer (96 kg P_2O_5/fad.) within 30 or 60 kg N/fad. resulted in the highest values of sugars content in dry seeds. This result indicates that both wide spacing and high level of P-fertilizer are more effective in increasing sugars dry seeds content more than the effect of N- fertilizer level.

Table (18): Effect of second order interaction among sowing rate, nitrogen and phosphorus fertilization level on the sugars percentage of common bean seeds.

Characters / Treatments			1992			1993		
			Reducing	Non-reducing	Total	Reducing	Non-reducing	Total
Fert. level N	P_2O_5	sow.rate kg/fad.	Effect of sow.rate X N X P-levels					
		20	3.6	7.8	11.4	3.2	8.2	11.4
	32	30	3.5	8.5	12.0	3.0	6.8	9.8
		40	3.4	10.3	13.7	2.9	12.1	15.0
		20	3.6	13.5	17.1	3.4	14.9	18.3
30	64	30	3.9	7.5	11.4	3.0	11.0	14.0
		40	3.7	7.0	10.7	3.0	9.8	12.8
		20	3.6	14.8	18.4	3.2	16.8	20.0
	96	30	3.6	4.6	8.2	3.0	15.2	18.2
		40	3.6	9.7	13.3	3.2	13.0	16.2
		20	4.0	11.7	15.7	3.0	8.9	11.9
	32	30	3.7	12.3	16.0	2.9	10.2	13.1
		40	3.6	10.6	14.2	3.2	11.4	14.6
		20	3.6	6.5	10.1	3.3	8.3	11.6
60	64	30	3.6	6.3	9.9	3.3	7.8	11.1
		40	3.5	12.7	16.2	3.1	13.7	16.8
		20	3.6	15.4	19.0	3.0	10.9	13.9
	96	30	3.6	10.3	13.9	3.2	10.4	13.6
		40	3.6	7.7	11.3	2.4	13.7	16.1
		20	3.2	12.1	15.3	3.0	12.2	15.2
	32	30	3.3	11.7	15.0	3.0	14.2	17.2
		40	3.2	10.1	13.3	2.9	13.3	16.2
		20	3.3	8.3	11.6	2.9	11.6	14.5
90	64	30	3.2	9.3	12.5	3.0	8.2	11.2
		40	3.7	10.9	14.6	3.0	8.1	11.1
		20	3.6	12.7	16.3	3.2	12.3	15.5
	96	30	3.3	9.1	12.4	3.4	13.9	17.3
		40	3.6	12.7	16.3	3.2	8.9	12.1
L.S.D. at 0.05			0.2	0.7	0.8	N.S.	0.9	0.8

4.4.c. Protein and total carbohydrates percentage and yield content (kg/fad.):

4.4.c.1. Effect of sowing rate:

Data presented in Table (19) show the effect of sowing rate on the dry seed content of proteins and carbohyrates either as percentage or total yield content (kg/fad). Such data show that the dry seeds components were significantly affected in this respect. The same results show that the lowest used rate of seeds (20 kg seeds/fad.) resulted in the significantly highest percentage of either protein or carbohydrates in the dry seeds except protein percentage in the second season which showed highest values with 30 kg seeds/fad. Such result is due to the favourable effect of low plant density on plant vegetative growth, higher photosynthetic pigments content, higher plant mineral uptake and also higher plant yielding ability as discussed in Tables (1, 4, 7 and 10). Meanwhile, the yield of either protein or carbohydrates expressed as kg/fad. was continously, gradually and significantly increased with increasing plant density which was increased with increasing sowing rate from 20, 30 up to 40 kg seeds/fad. Obtained results may be explained on the base that such dry seed components expressed as yield/fad. are resulted from the multiplication of the percentage of each by the dry seed yield/fad. Hence, protein and carbohydrates yield followed the same trend of dry seed yield/fad. It is obvious from such data that obtained results are going in the same trend in both growing seasons.

Concerning the effect of sowing rate on protein percentage, similar results were obtained by Abdel-Aal (1979) and Abul-Naas *et al.* (1986) on soybean who indicated that increasing plant spacing increased crude protein in seeds. However, contra results were obtained by Sultan (1978) on soybean who found that protein percentage increased by increasing seed rate. Furthermore, Saleh *et al.* (1980) and Morsy (1986) on cowpea stated that seed protein content was not affected by plant spacing.

Table (19): Effect of sowing rate, nitrogen or phosphorus fertilization level on the protein and carbohydrates percentage as well as their yield/fad. of common bean seeds.

Characters / Treatments	1992				1993			
	Protein %	Carbo-hydrates %	Protein yield kg/fad.	Carbo-hydrates yield kg/fad.	Protein %	Carbo-hydrates %	Protein yield kg/fad.	Carbo-hydrates yield kg/fad.
kg seed /fad.	**Effect of sowing rate**							
20	21.2	36.0	119.0	201.4	22.6	36.7	175.7	286.1
30	21.0	33.9	141.2	227.4	23.3	35.8	209.0	321.9
40	20.3	34.2	154.9	260.4	22.7	33.9	218.2	326.6
L.S.D. at 0.05	0.6	0.4	3.0	1.7	0.4	0.4	2.8	2.3
kg N/fad.	**Effect of N-level**							
30	20.4	34.9	128.1	218.6	22.7	35.7	134.6	212.7
60	20.8	34.7	143.7	239.2	23.3	34.9	192.8	289.4
90	21.3	34.4	143.5	231.3	22.6	35.5	275.5	432.5
L.S.D. at 0.05	0.3	0.3	2.0	2.7	0.2	0.4	2.0	2.3
kg P_2O_5/fad.	**Effect of P-level**							
32	20.1	34.6	135.2	232.6	22.4	35.4	181.9	287.5
64	20.6	35.4	129.1	221.6	23.4	35.9	209.1	320.7
96	21.9	34.2	150.8	235.1	22.8	35.1	212.0	326.4
L.S.D. at 0.05	0.3	0.3	1.8	1.2	0.3	0.3	1.4	2.2

With regard to the total carbohydrates, obtained results disagree with those reported by Rahman and Rashid (1976) and Morsy (1986) on cowpea. who indicated that neither plant density nor plant spacing affect total carbohydrates content in the dry seeds.

4.4.c.2. Effect of nitrogen fertilization level:

Results illustrated in Table (19) show that increasing nitrogen fertilizer level did not show clear or stable effect on the percentage of either protein or carbohydrates of dry seeds. Whileas, increasing nitrogen fertilizer level up to 60 kg N/fad in the first season and up to 90 kg N/fad in the second one significantly increased the yield of protein and carbohydrates/fad. Such favourable effect of increasing N-fertilizer level on the yield of protein and carbohydrates in dry seeds of common bean per faddan is mainly attributed to the effect of N-fertilizer on the dry seed yield itself where the effect on percentage of such components in dry seeds was not clear. Generally, it may be stated that the promoting effect of nitrogen fertilizer in building and accumulating protein and carbohydrates may be due to increasing the protein synthesis and activity of carbohydrates hydrolyizing enzymes.

Concerning the effect of nitrogen fertilization level on protein dry seeds content, obtained results agree with those reported by El-Bakry *et al.* (1980), Samtsevich *et al.* (1980) and Araya *et al.* (1981) on bean who found that increasing N-application level increased protein N-content in dry seeds. In this respect, the findings of each of Dhage *et al.* (1984), Morsy (1986), Khalil (1990) and Turkhede *et al.* (1991) on different legume crops supported also the results of this work where protein N-content of dry seed increased by increasing nitrogen fertilizer levels. On the other hand, contra results were reported by Velaquez *et al.* (1988) on bean, Abul-Naas *et al.* (1986) and Solh *et al.* (1986) on soybean who did not find any effect of increasing N-fertilizer levels in this respect.

With regard to protein yield, such results are in harmony with those of Ries (1971) and Edje *et al.* (1975) on beans who noticed that protein yield was increased by increasing N-level.

Concerning the effect of nitrogen fertilization level on total carbohydrates content of the dry seed, obtained results are in agreement with those reported by Morsy (1986) and Khalil (1990) on cowpea who found that increasing N-fertilizers level increased carbohydrates content of the dry seed.

4.4.c.3. Effect of phosphorus fertilization level:

Concerning protein and carbohydrates percentage in dry seeds as affected by level of phosphorus fertilizer, data shown in Table (19) show that although significant differences between values of such components are detected, no constant trend was observed. Furthermore, with respect to the effect on the yield of protein and carbohydrates, it is evident from data in the same table that the highest level of phosphorus fertilizer (96 kg P_2O_5/fad) resulted in the highest yield of studied dry seed components. Obtained results are going in the same trend at both growing seasons. It is also evident that such components behaved similary as dry seed yield/fad. where its effect was more pronounced than the percentage of such components.

Concerning the effect of phosphorus fertilization level on protein percentage, similar results were obtained by Kothari and Saraf (1986) on *Vigna radiata* and Turkhed *et al.* (1991) on soyabean who indicated that phosphorus application had no clear effect on seed protein content. However, contra results were obtained by Abd-El-Hadi *et al.* (1984) on soybean and Salem and El-Massri (1986) on *Vicia faba* who showed that increasing phosphorus fertilizer levels increased seed protein content. Meanwhile, obtained results disagree with those reported by Aulakh and Pasricha (1977) and Barkas (1981) on bean and Dhage *et al.* (1984) on *Vigna mungo* who indicated that increasing

phosphorus application decreased seeds protein content. Moreover, similar disagreement was reported by El-Bakry *et al.* (1980) on bean who found that increasing phosphorus level had no effect in this respect.

Concerning total carbohydrates, obtained results are in agreement with those reported by El-Bakry *et al.* (1980) on snap bean and Midan *et al.* (1980-a) on bean who demonstrated that increasing P-fertilizer levels increased total carbohydrates content in dry seeds. However, findings of this work disagreed with those of Kamel (1994) on cowpea who found that total carbohydrates content in cowpea seeds were not affected by foliar application of phosphorus.

With regard to protein yield, similar findings were reported by Abd-El-Hadi *et al.* (1984) on soybean and Kothari and Saraf (1986) on *Vigna radiata* who supported the results of this work where they demonstrated that crude protein yield (kg/unit area) was increased by increasing phosphorus levels.

4.4.c.4. Effect of first order interaction between sowing rate and nitrogen fertilization level:

Data presented in Table (20) show the effect of interaction between sowing rate and nitrogen fertilizer level on protein and carbohydrates percentage and their yield/fad. Such data indicated that significant differences between different combinations may be detected in this respect. The lowest used rate of seeds (20 kg N/fad.) in combination 30 kg N/fad. in the first season and 60 kg N/fad. in the second one resulted in the highest values of both protein and carbohyrates percentage.

However, with regard to the effect of such interaction on the yield (kg/fad.) of protein and carbohydrates, the same data show that sowing rate at 40 kg seeds/fad. within 60 kg N/fad. led to the production of dry seeds containing the highest protein and

Table (20): Effect of first order interaction between sowing rate and/or nitrogen and phosphorus fertilization level on the protein and charbohydrates percentage as well as their yield/fad. of common bean seeds.

Characters / Treatments		1992				1993			
		Protein %	Carbo-hydrates %	Protein yield kg/fad.	Carbo-hydrates yield kg/fad.	Protein %	Carbo-hydrates %	Protein yield kg/fad.	Carbo-hydrates yield kg/fad.
N sow.rate kg/fad.		**Effect of sow. rate X N-level**							
	20	21.5	37.8	100.4	176.6	22.1	36.7	117.6	196.1
30	**30**	21.0	33.4	137.1	218.0	23.9	37.1	142.6	222.2
	40	18.7	33.7	142.0	255.9	22.0	32.6	142.1	211.4
	20	21.0	36.1	124.5	214.1	23.9	37.5	172.3	271.1
60	**30**	20.2	33.7	137.6	229.7	22.2	35.7	185.6	299.4
	40	21.2	34.4	168.2	273.0	23.7	33.8	218.3	312.2
	20	21.2	34.2	137.4	221.8	21.8	35.9	235.3	388.3
90	**30**	21.7	34.6	153.4	224.6	23.8	34.6	300.4	437.6
	40	21.1	34.5	139.5	228.2	22.3	35.3	293.4	465.3
L.S.D. at 0.05		0.5	0.5	3.5	4.7	0.4	0.7	3.4	4.1
P_2O_5 sow.rate kg N/fad.		**Effect of sow.rate X P-level**							
	20	20.8	37.2	117.2	209.5	22.7	37.8	161.2	269.4
32	**30**	20.1	34.5	140.8	241.8	23.0	36.5	198.9	316.9
	40	19.4	32.1	146.5	242.4	21.5	32.1	183.7	275.4
	20	21.3	35.9	117.6	198.3	23.1	36.0	177.8	278.3
64	**30**	20.8	36.0	132.4	229.3	23.7	36.5	207.4	320.6
	40	19.6	34.3	135.5	237.0	23.5	35.1	242.4	363.2
	20	21.7	35.0	128.7	207.6	22.3	36.3	188.7	308.3
96	**30**	22.1	31.2	155.5	219.7	23.3	34.6	220.5	328.6
	40	21.8	36.3	167.4	278.7	22.9	34.5	226.8	343.0
L.S.D. at 0.05		0.6	0.5	3.1	2.0	0.4	0.6	2.4	3.8
N P_2O_5 kg/fad.		**Effect of N X P-levels**							
	32	21.1	36.2	131.4	225.3	22.7	34.4	147.5	222.2
30	**64**	17.9	36.1	109.4	220.4	21.9	38.3	133.6	232.1
	96	22.2	32.7	142.6	209.7	24.1	33.7	127.0	176.1
	32	18.0	34.8	123.2	238.0	23.0	36.5	157.7	249.1
60	**64**	22.8	34.0	141.0	210.1	23.3	33.4	187.7	268.3
	96	21.6	35.3	164.5	268.6	22.1	37.2	219.5	369.3
	32	21.1	32.8	149.4	232.1	22.2	35.4	245.8	392.1
90	**64**	21.1	36.0	136.6	232.9	23.5	35.9	298.1	456.2
	96	21.8	34.5	143.5	226.8	22.8	34.5	290.1	439.6
L.S.D. at 0.05		0.6	0.5	3.1	2.0	0.4	0.6	2.4	3.8

carbohydrates yield/fad in the first season. Meanwhile, the highest used level of nitrogen fertilizer (90 kg N/fad). Combined with higher rates of seeds (30 or 40 kg/fad.) were the most effective treatments in the second season. Moreover, obtained results showing the effect of interaction between sowing rate and nitrogen fertilization level on both protein and total carbohydrates contents of dry seeds are supported by findings of Morsy (1986) on cowpea who found that increasing plant spacing within nitrogen fertilization increased the seeds protein and total carbohydrates contents.

4.4.c.5. Effect of first order interaction between sowing rate and phosphorus fertilization level:

The effect of sowing rate in combination with phosphorus fertilizer level is illustrated by the data presented in Table (20). Moreover, differences between the different combinations in this respect were statistically significant. With regard to the effect of such interaction on the percentage of protein in dry seeds, sowing seeds at the rate of 30 kg/fad. combined with the application of 96 kg P_2O_5/fad. resulted in higher values in this respect. However, concerning effect of such interaction on carbohydrates percentage in dry seeds, the lowest used level of phosphorus fertilizer (32kg P_2O_5/fad.) within also the lowest used rate of sowing seeds (20 kg seeds/fad.) resulted in the highest percentage of carbohydrates in dry seeds. Such results are going in the same trend at both growing seasons. Concerning the effect of interaction between sowing rate within phosphorus fertilizer level on yield of both protein and carbohydrates, the same data in Table (20) showed that the highest values were obtained in case of sowing rate of 40 kg/fad. within the highest used phosphorus fertilizers level (96 kg P_2O_5/fad.) in the first season and within the medium used level (64 kg P_2O_5/fad.) in the second one.

4.4.c.6. Effect of first order interaction between nitrogen and phosphorus fertilization levels:

Data presented in Table (20) show the effect of interaction between nitrogen and phosphorus fertilizers levels on the percentage and yields of both protein and carbohydrates in dry seeds. Although significant differences may be detected between the different values of each of the protein and carbohydrates percentages in dry seeds, no clear trend at both seasons may be observed. Generally, it may be stated that application of 30 kg N within 96 kg P_2O_5/fad. resulted in higher values of protein percentage in dry seeds. Moreover, with regard to the effect of such interaction on carbohydrates percentage, application of 30 kg N within 64 kg P_2O_5/fad. showed the highest values in this respect at both growing season. Concerning the effect of nitrogen and phosphorus fertilizers levels when combined together on the yield of both protein and carbohydrates, the same data at table (20) indicated that application of 60 kg N within 96 kg P_2O_5/fad. in the first season or 90 kg N within 64 kg P_2O_5/fad. in the second season resulted in the highest protein and carbohydrates yield in dry seeds.

Concerning the effect of interaction between nitrogen and phosphorus fertilization level on protein seed contents, obtained findings are in confirmity with those reported by Borisonik *et al.* (1978), El-Bakry *et al.* (1980) and Abedeen *et al.* (1983) on bean, Saleh *et al.* (1980) on cowpea and Nagre *et al.* (1991) on soybean who demonestrated that seed protein concentration in the dry seeds increased by increasing N, P and K fertilizers levels.

With regard to total carbohydrates seed content, obtained results are supported by those of Rahman and Rashid (1976) on cowpea who indicated that total carbohydrates content was increased by increasing NPK fertilization level.

4.4.c.7. Effect of second order interaction among sowing rate, nitrogen and phosphorus fertilization levels:

Data illustrated in Table (21) show the effect of the second order interaction among sowing rate and each of nitrogen and phosphorus fertilizers levels on the percentage and yields/fad. of both protein and carbohydrates in dry seeds. Such data indicated that values of each of studied parameters significantly differed. As regard to such effect on the percentage of protein, the same data show that sowing 40 kg seeds/fad. and fertilization with 60 kg N within 64 kg P_2O_5/fad. resulted in the significantly highest values in this respect. Obtained results of this work disagree with those reported by Saleh *et al.* (1980) and Morsy (1986) on cowpea who found that widest plant spacing and the highest level of NPK fertilizers produced the highest seed protein content.

Concerning the effect of such second order interaction on the percentage of carbohydrates in dry seeds, data at the same table indicated that sowing 20 kg seeds/fad. combined with application of 60 kg N within 32 kg P_2O_5/fad. resulted in the significantly highest values of carbohydrates percentage in dry seeds. It is also evident from the same data that the values of each of protein and carbohydrates percentages similary behaved in both seasons of this work.

With regard to the effect of second order interaction of all studied factors on the protein and carbohydrates yield (kg/fad.) in dry seeds, data presented in Table (21) show that the highest yields of both protein and carbohydrates are resulted with using the highest rate of seeds (40 kg/fad.) combined with the highest used level of phosphorus fertilizer (96 kg P_2O_5/fad.) within the medium used level of nitrogen fertilizer (60 kg N/fad.) in the first season but within 64 kg P_2O_5 and 90 kg N/fad. in the second season. Such variation in the tri-interaction effect on the yield of both protein and carbohydrates in dry seeds at both growing seasons is mainly due to the variation resulted between seasons on

Table (21): Effect of second order interaction among sowing rate, nitrogen and phosphorus fertilization level on the protein and carbohydrates percentage as well as their yield/fad. of common bean seeds.

Characters / Treatments			1992				1993			
			Protein %	Carbo-hydrates %	Protein yield kg/fad.	Carbo-hydrates yield kg/fad.	Protein %	Carbo-hydrates %	Protein yield kg/fad.	Carbo-hydrates yield kg/fad.
Fert. level N	P_2O_5	sow.rate kg/fad.	Effect of sow. rate X N X P-levels							
		20	21.2	39.6	93.6	174.8	21.8	37.1	125.6	213.8
	32	30	21.1	35.3	147.9	247.3	23.2	36.1	159.7	248.5
		40	20.9	33.7	152.5	245.9	22.4	30.1	150.8	202.6
		20	21.3	37.8	95.4	169.3	23.1	36.4	128.4	202.3
30	64	30	18.3	36.5	108.9	217.3	22.6	40.2	133.1	236.8
		40	20.1	34.0	159.5	269.8	20.1	38.4	135.3	258.5
		20	22.0	36.0	112.6	184.3	22.2	36.7	103.0	170.3
	96	30	23.5	35.5	155.6	235.1	23.0	35.2	117.9	188.1
		40	21.0	33.5	158.5	252.9	23.5	32.0	139.0	189.3
		20	20.6	40.7	113.3	224.0	21.8	40.7	113.4	211.7
	32	30	21.4	31.7	149.9	222.1	22.7	36.1	168.5	267.9
		40	20.2	31.9	162.8	257.2	20.9	32.5	164.1	255.3
		20	22.2	32.1	132.1	191.1	23.0	32.3	151.3	212.5
60	64	30	21.9	36.7	136.7	229.0	23.0	35.8	177.7	276.6
		40	24.3	33.3	155.5	213.1	24.5	32.1	239.9	314.3
		20	20.2	35.4	128.0	224.2	20.9	36.5	205.7	359.3
	96	30	21.4	32.6	154.0	234.7	21.0	35.2	208.9	350.0
		40	23.2	37.0	216.7	345.7	23.9	36.8	238.9	367.8
		20	20.5	31.2	143.0	217.6	20.5	35.5	213.2	369.3
	32	30	21.6	36.5	151.0	255.7	23.2	37.2	271.6	435.4
		40	21.2	30.7	154.7	224.0	22.3	33.5	247.9	372.4
		20	20.3	37.8	124.7	232.2	21.2	39.4	233.5	434.0
90	64	30	22.3	34.8	154.1	240.5	22.6	33.3	287.0	422.9
		40	20.7	35.5	132.5	227.2	23.2	34.8	336.0	504.0
		20	22.9	33.7	145.0	213.5	23.7	32.6	259.8	357.5
	96	30	21.3	32.5	155.4	237.1	22.8	33.4	305.2	447.2
		40	21.3	37.4	130.9	229.8	21.4	37.6	296.8	521.6
L.S.D. at 0.05			1.0	0.8	5.3	3.5	0.8	1.0	4.2	6.5

the dry seed yield per faddan as shown in Table (15). Hence, it may be concluded that the dry seeds constituents of protein and carbohydrates measured as kg/fad. is correlated with the dry seeds yield/fad. where the same treatments produced the highest dry seed yield/fad. and the highest protein and carbohydrates yields. Finally, sowing seeds of cv. Giza-3 at the rate of 40 kg/fad. and fertilizing plants with 60-90 kg N/fad. within 64-96 kg P_2O_5/fad. may be recommended to produce the highest dry seed yield with the highest protein and carbohydrates yields.