4. RESULTS AND DISCUSSION

The importance of phosphorus application on plant nutrition, especially for vegetative growth, dry seed yield and its components as well as chemical composition of plant foliage and dry seeds are studied in two separate experiments on common bean plants cv. Nebraska as follows:

4.1. First Experiment:

Effect of phosphorus level and source on growth, dry seed yield and quality of common bean *(Phaseolus vulgaris* L.*).*

4.1.1. Vegetative growth of common bean as affected by level /or source of P-application:

The effect of level and source of P-application on vegetative growth characteristics of common bean i.e., plant height, number of leaves and branches per plant, stem diameter, fresh and dry weight per plant are presented in Tables (1, 2).

4.1.1.a. Plant height as affected by level and / or source of P-fertilizer:

Data on the effect of phosphorus fertilizer level on plant height, (Table, 1) show that increasing level of phosphorus fertilizer from 0 up to 32 kg P_2O_5 / fed led to a significant increase in plant height in the second season only. Meanwhile, fertilizing common bean plants with 40 kg P_2O_5 / fed did not significantly increase plant height than that of 32 kg P_2O_5 / fed as a general trend in both

Table (1) Effect of P-level / or P- source on vegetative growth of common bean during summer seasons of 1998&1999.

Treatments	Plant height (cm)	No. of Leaves / plant	No. of branches /plant	Stem diameter (cm)	Fresh wt. g/plant	Dry wt. g/plant	Plant height (cm)	No. of leaves /plant	No. of branches /plant	Stem diameter (cm)	Fresh wt. g/plant	Dry wt. g/plant
Kg P_2O_5/fed	First season (1998)						Second season (1999)					
O (P0)	45.34	13.33	8.30	0.69	113.96	28.48	37.13	12.10	7.32	0.56	64.05	16.00
24 (P1)	47.21	14.91	[illegible]	0.74	125.71	31.42	40.43	12.60	7.69	0.57	71.09	17.77
32 (P2)	48.69	15.75	8.25	0.77	145.02	36.25	44.07	14.16	9.01	0.59	87.67	21.91
40 (P3)	48.01	15.66	8.50	0.77	135.33	33.84	43.89	14.29	8.75	0.62	82.33	20.85
L.S.D at.5%	N. S	1.60	N. S	0.02	5.15	0.42	5.14	N. S	1.15	N. S	2.08	0.47
P – source	First season (1998)						Second season (1999)					
SP	47.25	13.87	8.56	0.74	129.84	32.45	40.84	13.78	7.95	0.59	77.07	19.26
MAP	47.14	15.25	[illegible]	0.74	127.82	31.95	40.93	12.23	8.25	0.57	69.67	17.41
DAP	47.55	15.62	[illegible]	0.74	132.34	33.08	42.37	13.85	8.38	0.62	82.12	20.52
L.S.D at.5%	N. S	1.39	N. S	N. S	3:85	0.32	N. S	1.33	N. S	N. S	2.97	0.30

seasons. Such increment in plant growth by P-application could be referred to the role of P on root proliferation and growth ***(Tisdale and Nelson, 1975 and Ohlrogge, 1962)*** as well as its effect on cell energy through organic phosphate compounds; ADP and ATP. This favourable role of P-application level on plant height is in agreement with those results obtained by ***El-Bakry et al. (1980), Mahatanya (1980), Acuna and Cordero (1989), Abou El-Hassan et al. (1993)*** on common bean. Furthermore, results agree also with ***Abd El-Hafez (1994)*** on common bean who found that plant height was increased by increasing P-fertilizer level up to 96 kg P_2O_5 / fed. Many investigators pointed out favourable role of P-application on plant height of other legume crops among them, ***Goverdhan (1985), Hassan et al. (1990)*** and ***Mohamed et al. (1999)*** on cowpea, ***Salem and El-Massri (1986), Etman et al. (1991), Hamada (1992), radwan (1992), El-Bana And Soliman (1994)*** on faba bean and ***Hassan et al. (1993)*** on pea. On the other hand, ***El-Sawah et al. (1985)*** on broad bean who showed that increasing P_2O_5 application up to 48 kg / fed decreased plant height. Meanwhile, ***Farag et al. (1987)*** on cowpea who reported that plant height was not affected by in creasing P_2O_5 level from 24, 48 up to 72 kg P_2O_5.

Concerning with the effect of P-fertilizer source on plant height, (Table, 1) clear that plant height was not significantly differed due to the source of P-fertilizer, as shown in both seasons. It means that there were not differences between each sources on plant height.

According to the interaction effect of P-level within P-source on plant height, data Table (2) did not show any significant effect in this respect in both seasons. It means that each of P-level or P-source affects on plant height separately.

4.1.1.b. Number of leaves per plant as affected by level and / or source of P-fertilizer:

Regarding with the effect of P-application level on number of leaves / plant, data Table (1) show that increasing P-level led to a significant increase in number of leaves / plant in the first season only up to 32 kg P_2O_5 / fed. Although the same trend was noticed in the season, but variances were not significant. This result may be due to the stimulating effect of P-application on root proliferation ***(Ohlrogge, 1962)***, cell elongation and carbohydrate assimilation ***(Abdo, 1998)***. Such results are in harmony with those of ***Manrique (1986), Jonathan and Emanuel (1991) and Abd El-Hafez (1994)*** on beans. Many investigators indicated the favourable role of P-fertilizer on number of leaves / plant of other legume crops, ***Abd El-Wahab et al. (1979) and Etman et al. (1991)*** on *Vicia faba*, ***Farag et al. (1987)*** on cowpea and ***Omar et al. (1990)*** on Pea who reported that number of leaves / plant were increased with increasing P_2O_5 application from 32 up to 72 kg P_2O_5 / fed.

Concerning with the effect of P-fertilizer source on number of leaves / plant, Table (1) show that plants

Table (2) Effect of P-level within P-source on vegetative growth of common bean during summer seasons of 1998&1999.

Treatments	Plant height (cm)	No. of Leaves / plant	No. of branches /plant	Stem diameter (cm)	Fresh wt. g/plant	Dry wt. g/plant	Plant height (cm)	No. of leaves plant	No. of branches /plant	Stem diameter cm)	Fresh wt. g/plant	Dry wt. g/plant
	First season 1998						Second season 1999					
0(Cont.) SP	45.20	10.50	8.75	0.71	111.91	27.97	[illegible]	2.72	6.8	.52	56.4	14.
MAP	45.70	15.00	8.00	0.70	116.91	29.22	[illegible]	2.47	7.8	.58	68.8	17.
DAP	45.12	14.50	7.25	0.66	113.08	28.27	[illegible]	1.12	7.	.57	66.8	16
24 (P1) SP	48.40	15.00	8.75	0.76	125.24	31.31	[illegible]	2.90	7.	.62	72.0	18.
MAP	46.52	15.00	8.50	0.72	131.91	32.97	[illegible]	1.15	7.	.53	68.9	17.2
DAP	46.72	14.75	8.75	0.73	119.99	29.99	[illegible]	3.75	7.	.58	72.2	18.
32 (P2) SP	48.22	15.00	8.50	0.74	147.91	36.97	[illegible]	5.05	9.	.60	96.7	24.
MAP	47.80	15.00	7.25	0.79	126.66	31.66	[illegible]	1.70	8.	.54	65.3	16.
DAP	50.05	17.25	9.00	0.80	160.49	40.12	[illegible]	5.75	9.	.64	100.8	25.
40 (P3) SP	47.20	15.00	8.25	0.75	134.33	33.58	[illegible]	4.45	8.	.61	83.0	20
MAP	48.55	16.00	8.75	0.78	135.83	33.95	[illegible]	3.62	9.	.63	75.5	18.
DAP	48.30	16.00	8.50	0.77	135.83	34.00	[illegible]	4.80	8.	.61	88.4	22
L.S.D at 0.05	N. S	N. S	N. S	N. S	7.71	0.63	N. S	N. S	0.9	N. S	5.94	0.

fertilized with DAP or MAP gave higher and significantly increase number of leaves / plant as compared with plants fertilized with SP. This trend was true in both seasons. The superiority of DAP or MAP as sources of P-fertilizer may be due to that these fertilizers contain N in the ammonium form (NH_4^-) which encourage the uptake of phosphorus (PO_4^{-3}) ***(Tisdale and Nelson, 1975).*** According to the theory of anion-cation balance by ***Mengel and Kirkby (1982)***; NH_4^+ acts as cations and PO_4^{-3} acts as anion, therefor, when plants took up NH_4^+ it need to take up PO_4^{-3} in order to keep the anion-cation balance in plant tissues. Added to that, DAP and MAP are given in granulated form, but super phosphate is given in a powder form which is easily adsorption or fixed on soil complex as compared with the granulated forms. These results are in agreement with those obtained by ***Zennat and Sharma (1990)*** on tomato who mentioned that the highest number of leaves / plant were obtained with application of 0.5 g of DAP / pot.

According to the interaction effect of P-level within P-source on number of leaves per plant, data Table (2) did not show any significant interaction effect on number of leaves / plant in both seasons. It means that each of P-level or P-source affects on number of leaves / plant separately.

4.1.1.c. Number of branches / plant and stem diameter as affected by level and / or source of P-fertilizer:

Concerning with the effect of P-fertilizer level on number of branches and stem diameter per plant, data

Table (1) show that increasing P-level significantly increased number of branches / plant and stem diameter up to 32 kg P_2O_5 / fed. Heavier P-application; 40 kg P_2O_5 / fed did not significantly increased each of number of branches / plant and stem diameter. This result was true in one season only. Whereas, variances were not significant in the first season as for number of branches / plant and in the second season for stem diameter. Such increment in plant growth could be referred to the role of P on root proliferation which consequently encouraged plant growth ***(Tisdale and Nelson, 1975 and Ohlrogge, 1962).***

This result is in harmony with those of ***Mahboob et al. (1984)*** on mung bean and ***Abd El-Hafez (1994)*** on bean who mentioned that number of branches / plant was increased by increasing P-level up to 96 kg P_2O_5 / fed. Some results are also confirmed with ***Abd El-Wahab et al. (1979), El-Sawah et al. (1985), Salem and El-Massri (1986) and Etman et al. (1991)*** on *Vicia faba*, ***Kothari and Saraf (1986)*** on *Vigna radiata* and ***Omar et al. (1990) and Hassan et al. (1993-a)*** and ***Ali (2000)*** on pea. On the other hand, ***Farag et al. (1987)*** on cowpea who reported that number of branches / plant was not affected by increasing P_2O_5 level from 24 up to 72 kg P_2O_5 / fed.

Regarding with the effect of phosphorus source on number of branches / plant and stem diameter, data Table (1) did not show any significant increase in this respect in both seasons. It means that there were not differences between sources on number of branches / plant and stem diameter.

With regard to interaction effect between P-level and P-sources on number of branches / plant and stem diameter, data Table (2) show that plants supplied with 32 kg P_2O_5 / fed as DAP (P_2 x DAP) gave higher number of branches / plant as compared with other treatments especially in the second season of 1999. However, data did not show any significant effect on stem diameter in both seasons. The favourable effect of adding phosphorus at P_2 level (32 kg P_2O_5 / fed) with DAP on plant growth, number of branches / plant and stem diameter could be referred to that P_2 level; 32 kg P_2O_5 / fed seemed to be the optimum level for common bean production under the field conditions of this experiment i.e.; phosphorus fertilizer as DAP was added at two times; 25% at germination time and 75% at flowering stage.

4.1.1.d. Fresh and dry weight per plant as affected by level and / or source of P-fertilizer:

Concerning with the effect of P- fertilizer level on fresh and dry weight / plant, data Table (1) show that increasing P-fertilizer level led to a significant increase in fresh and dry weight / plant from 0, 24 up to 32 kg P_2O_5 / fed. This result was true during the two seasons of this experiment. Heavy application of P up to 40 kg P_2O_5 / fed decreased plant fresh and dry weight as compared with that of plants supplied with 32 kg P_2O_5 / fed, as shown in both seasons. The stimulating effect of P-application on plant growth may be referred to the role of phosphorus on root proliferation and growth ***(Tisdale and Nelson, 1975 and Ohlrogge, 1962)*** as well as it's effect on cell energy through organic phosphate compounds; ADP and ATP. These results are in agreement with those obtained by ***Vidal et al. (1982), Ssali and Keya (1983), Chagas et al. (1987), Neptune and Perez (1987),Shafshak (1991)*** and ***Abou El-Hassan et al. (1993)*** all working on beans and indicated that dry matter content of bean plants was significantly responded to the phosphorus application. Moreover, ***Rhoads (1991), Moraghan (1993)*** on *Phaseolus vulgaris* and ***Abd El-Hafez (1994)*** on bean reached to the same results and reported that fresh and dry weight per plant were increased by increasing level of P-application from 0 up to 96 kg P_2O_5 / fed. Many investigators working on other legume crops, also mentioned the favourable role of P on plant growth among them, ***Abd El-Wahab et al. (1979), El-Sawah et al. (1985) and Radwan (1992)*** on *Vicia faba*, ***Midan et al. (1982)*** on pea, ***Farag et al. (1987), Hassan et al. (1990) and Mohamed et al. (1999)*** on cowpea.

Concerning with the effect of P-source on fresh and dry weight / plant, it is clear from Table (1) that plants fertilized with DAP gave higher fresh and dry weight / plant as compared with the other sources; MAP or SP. This trend was true in both seasons of the experiment. The superiority of DAP as source of P-fertilizer may be due to that this fertilizer contains N in the ammonium form (NH_4^+) which encourage the uptake of PO_4^{-3} ***(Tisdale and***

Nelson, 1975 and Abd El-All, 1999). According to the theory of ***Mengle and Kirkby (1982)***; NH_4^+ acts as cations and PO_4^{-3} acts as anions, therefore, when plants took up NH_4^+ it needs to take up PO_4^{-3} in order to keep the anion cation balance in plant tissues. Added to that, DAP or MAP are given in a granulated form, but super phosphate is given in a power form which is easily adsorbed or fixed on soil complex as compared with the granulated form. These results are in agreement with those obtained by ***Rhoads (1991), Rhoads et al. (1993)*** *on bean,* ***Dzhafarova and Ibragimov (1973), Heunni et al. (1973), Tamara (1975), Zaki et al. (1979), Dumas (1988), Zennat and Sharma (1990) and Fontes (1992)*** all working on tomato and ***Abd El-All (1999)*** on cauliflower who indicated that all used of P-sources encouraged plant growth and the highest growth was found in plants supplied with MAP or DAP as compared with SP or GTSP. Whereas, plant fresh weight was more responded to DAP as compared with MAP.

With regard to the interaction effect of P-level within P-source on fresh and dry weight, data Table (2) show that plants received DAP at 32 kg P_2O_5 / fed gave the highest significant increase in fresh and dry weight per plant as compared with all other tested treatments, in both seasons. This result may be referred to that plants can be absorb more PO_4^{-3} when added with NH_4^+ together in the DAP fertilizer [$(NH_4)_2$ HPO_4] which encourage plant growth ***(Tisdale and Nelson, 1975 and Gabal, 1982).*** This result is in agreement with those obtained by ***Bakry et al. (1988/b)*** on cowpea, ***Zaki et al. (1979), Zenate and***

Sharma (1990) and Fontes (1992) on tomato and *Abd El-All (1999)* on cauliflower who reported that fresh weight / plant was increased by application of DAP or MAP at 60 kg P_2O_5 / fed gave and led to higher growth as compared with SP or GTSP.

4.1.2. <u>Chlorophyll and carotenoids of common bean leaves as affected by level and / or source of P-application:</u>

Concerning with the effect of P-nutrition level on chlorophyll content of common bean leaves, data Table (3) evident that chlorophyll a, b and total chlorophyll as well as carotenoids content were significantly and gradually increased by increasing P-application level from 0, 24 up to 32 kg P_2O_5 / fed. This trend was true in both seasons. Heavy P-application level at 40 kg P_2O_5 / fed did not significantly increase chlorophyll a, b, total chlorophyll and carotenoids content of leaves.

Moreover, plants supplied with 40 kg P_2O_5 / fed had lower chlorophyll and carotenoids content than those received 32 kg P_2O_5 / fed, indicating that 32 kg P_2O_5 / fed might be the optimum level of P-nutrition for common bean cv. Nebraska under field conditions of this work. The promotive effect of P on chlorophyll and carotenoids synthesis could be referred to the it's encourage effect on nutrients uptake, especially N, P and K. Such result is similar to those obtained by *Abaza (1991)* on bean, *El-Mansi et al. (1991)* on broad bean, *Metwally et al. (1995)*

Table (3) Effect of P-level or source on chlorophyll content of common bean leaves during summer seasons of 1998&1999.

Treatments	Chlorophyll (mg/100g)			Carotenoids mg/100g	Chlorophyll (mg/100g)			Carotenoids mg/100g
	a	b	Total		a	b	Total	
Kg P_2O_5/fed.	First season (1998)				Second season (1999)			
0 (p_0)	198.60	56.60	255.13	140.00	109.60	63.46	173.13	65.00
24 (p_1)	214.60	58.5	273.10	181.60	117.60	66.53	184.13	106.60
32 (p_2)	268.13	59.30	327.40	203.30	127.40	72.13	199.53	156.60
40 (p_3)	250.26	59.26	309.53	196.60	120.80	69.60	190.40	125.00
L.S.D at 0.05	0.33	0.67	1.88	5.06	2.29	1.23	4.60	8.04
P-source	First season (1998)				Second season (1999)			
SP	246.00	58.80	304.80	171.20	119.60	68.80	188.40	108.75
MAP	200.40	57.25	257.60	188.70	117.90	66.60	184.45	116.25
DAP	252.30	59.20	311.45	181.25	119.15	68.40	187.55	115.00
L.S.D at 0.05	2.06	0.86	4.36	8.80	0.95	0.86	1.80	5.52

and *Ali (2000)* on Pea, *Genchev et al. (1979)* on tomato, *Daufualt (1988)* on broccoli and *Eid and Mohamed (1989) and Abd El-All (1999)* on cauliflower.

Regarding with the effect of P-source on chlorophyll and carotenoids content of leaves, data Table (3) indicated that plants received DAP had higher total chlorophyll content as compared with other sources; SP & MAP, in the first season. Whereas, plants received DAP or SP had similar and higher total chlorophyll content in the second season. As for, the effect of P-source on carotenoids content (Table, 3) show that plants supplied with MAP or DAP contained higher carotenoids content than in plants received SP as a general trend in both seasons. This results could be referred to that DAP or MAP contain NH_4^+ $+PO_4^{-3}$ in one fertilizer which increase the uptake of N and P. Such result is similar to those obtained by *Abd El-All (1999)* on cauliflower who indicated that DAP or MAP application increased chlorophyll b and total chlorophyll content of leaves as compared with SP or GTSP.

Concerning with the interaction effect between P-fertilizer level and P-source, it is evident from Table (4) that chlorophyll a, total chlorophyll and carotenoids were high in plants supplied with 32 kg P_2O_5/ fed as DAP (P_2 x DAP), in both seasons. Although, chlorophyll b showed the same trend but variances were only significant in the second season. i.e. Adding DAP at 32 kg P_2O_5/ fed (P_2 x DAP) also had a superior effect of chlorophyll b.

Table (4) Effect of P-level within P- source on chlorophyll and carotenoids content of common bean leaves during summer seasons of 1998&1999.

Treatments kg P_2O_5/ fed.		Chlorophyll (mg/100g)			Carotenoids	Chlorophyll (mg/100g)			Carotenoids
		a	b	Total	mg/100g	a	b	Total	mg/100g
		First season (1998)				Second season (1999)			
0 (cont.) P0	SP	207.40	56.80	264.20	155	110.60	62.60	173.20	80.00
	MAP	160.80	55.80	216.60	125	109.20	66.60	171.80	50.00
	DAP	227.60	57.20	284.60	140	109.20	65.20	174.40	65.00
24 (P1)	SP	246.80	60.10	306.90	170	118.60	66.60	185.20	95.00
	MAP	167.00	56.40	223.40	210	117.20	66.60	183.80	135.00
	DAP	230.00	59.00	289.00	165	117.00	66.40	183.40	90.00
32(P2)	SP	274.60	59.50	334.10	180.	129.20	73.00	202.20	155.00
	MAP	208.20	57.60	265.870	190	121.20	68.00	189.00	115.00
	DAP	321.60	60.80	382.40	240.	132.00	75.40	207.40	200.00
40(P3)	SP	255.20	58.80.	314.00	180	120.00	73.00	193.00	105.00
	MAP	265.60	59.20	324.80	230	124.00	69.20	193.00	165.00
	DAP	230.00	59.80	289.80	180	118.40	66.60	185.00	105.00
							[illegible]	[illegible]	[illegible]

4.1.3. Dry seed yield and its components as affected by level and / or source of P-application:

The effect of level and / or source of P-fertilizer on dry seed yield and its components of common bean i.e. number of seeds per pod, number of pods per plant, seed index (100 – seeds weight), netting % and dry seed yield per plant or feddan are presented in Tables (5 & 6).

4.1.3.a. Number of seed / pod as affected by level and / or source of P-application:

Data on the effect of phosphorus fertilizer level on number of seeds per pod, data Table (5) show that increasing level of P-fertilizer up to 32 kg P_2O_5 / fed tended to increase number of seeds / pod, but variances were only significant in the second season. Whereas, increasing P-level up to 40 kg P_2O_5 / fed did not result any significant increase on number of seeds / pod as a general trend in both seasons. These result are in agreement with those obtained by ***Vidal et al. (1982)***, ***Gallo (1984), Mahboob et al. (1984) and Simthon et al. (1993)*** on common bean. ***Abd El-Hafez (1994)*** also mentioned that number of seeds / pod were responded to increasing P-fertilizer level up to 96 kg P_2O_5 / fed. On the other hand, ***El-Sawah et al. (1985)*** on broad bean and ***Kothari and Saraf (1986)*** on *Vigna radiata* noticed that number of seeds / pod did not show any significant variation under different phosphorus application level up to 48 kg P_2O_5 / fed in the first study and up to 26 kg P_2O_5 / ha in the second study.

Table (5) Effect of P-level or source on dry seed yield and its quality of common bean during summer seasons of 1998&1999.

Treatments	No. of Seeds /pod	No. of Pods /plant	Seed index 100 seeds/g	Netting %	Seed yield /plant (g)	Seed yield kg/fed.	No.of Seeds /pod	No .of Pods /plant	Seed index 100 seeds/g	Netting %	Seed yield /plant (g)	Seed yield kg/fed.
kg P_2O_5/fed.	First season (1998)						Second season (1999)					
0 (p_0)	3.30	14.65	46.58	68.81	22.35	639.682	2.70	16..20	32.58	60.56	13.55	387.300
24 (p_1)	3.48	17.22	48.00	71.40	26.38	753.967	2.80	20..27	34.66	67.19	19.49	557.142
32 (p_2)	3.54	17.51	49.75	73.23	30.83	880.950	3.20	18..96	40.41	72.23	23.71	677.777
40 (p_3)	3.47	17.13	49.91	72.93	29.47	855.634	3.10	18..32	39.41	70.80	22.77	650.790
L.S.Dat0.05	N. S	1.00	N. S	2.47	1.58	40.36	0.27	2.73	5.90	3.28	1.50	43.050
P-source	First season (1998)						Second season (1999)					
SP	3.41	16.46	48.50	72.01	27.72	792.856	2.95	18.42	35.43	63.75	18.87	539.285
MAP	3.39	15.71	47.87	71.85	25.39	734.523	2.91	18.92	36.06	67.15	18.99	542.850
DAP	3.55	17.70	49.31	70.92	28.66	819.047	3.00	18.72	38.81	72.19	21.78	622.618
L.S.Dat0.05	N. S	0.34	N. S	N. S	0.93	22.56	N. S	N. S	1.25	3.73	0.69	20.06

With regard to the effect of phosphorus source on number of seeds / pod, data Table (5) did not show any significant effect on number of seeds / pod, in both seasons.

Concerning with interaction effect of P-level within source on number of seeds per pod, data Table (6) did not show any significant effect in this respect in both seasons. It means that number of seeds per pod was mainly affect by P-fertilizer level and not by P-source or p-source within P-level. Results are confirmed with those results of *Gallo (1984), Mahboob et al. (1989), Smithon et al. (1993) and Abd El-Hafez (1994).*

4.1.3.b. Number of pods per plant as affected by level and / or source of P-application:

Regarding the effect of P-fertilizer level on number of pods / plant, data Table (5) show that increasing level of phosphorus fertilizer from 0 up to 24 kg P_2O_5 / fed or more led to a significant increase in number of pods per plant. However, plants supplied with 24, 32 or 40 kg P_2O_5 / fed gave similar number of pods per plant as shown in both seasons. Such results are in harmony with those of *Mahatanya (1980), Vidal et al. (1982), Thung et al. (1982), Frizzon et al. (1982), Sa-Me et al. (1982), Vieira (1986), Chagas et al. (1987) and Abd El-Hafez (1994)* all working on *Phaseolus vulgaris* and reported the favourable effect of P-nutrition on number of pods per plant. Many investigators working on the other legume crops among them, *Kothari and Saraf (1986), Farag et al. (1987) and*

Table (6) Effect of P-levels within source on dry seed yield and its common bean during 1998 &1999.

Treatments (P-level KgP$_2$O$_5$/fed) P-Source		No. of seed /pod	No. of pods /plant	Seed index 100 seeds/g	Netting %	Seed yield g/plant	Sec kg
First season (1998)							
Cont.(P0)	SP	3.2	14.73	46.75	68.85	21.74	6
	MAP	3.38	14.51	46.75	70.80	22.83	6
	DAP	3.34	14.71	46.25	66.80	22.49	6
24(P1)	SP	3.51	16.24	47.25	73.90	28.99	8
	MAP	3.37	16.55	47.00	71.40	25.99	7
	DAP	3.57	18.88	49.75	68.90	24.16	6
32 (P2)	SP	3.55	17.17	50.25	73.50	30.50	8
	MAP	3.38	15.77	47.75	72.20	25.33	7
	DAP	3.70	19.58	51.25	74.00	36.66	1
40 (P3)	SP	3.38	17.72	49.75	71.80	29.66	8
	MAP	3.43	16.02	50.00	73.00	27.41	8
	DAP	3.60	17.65	50.00	74.00	31.33	8
L.S.D at 0.05		N. S	2.37	N. S	N. S	1.87	
Second season (1999)							
Cont.(P0)	SP	2.72	14.43	33.50	56.40	12.99	3
	MAP	2.70	18.42	31.25	57.20	13.99	3
	DAP	2.70	15.77	33.00	68.10	13.66	3
24(P1)	SP	2.80	18.86	35.00	68.50	19.99	5
	MAP	2.87	22.75	32.50	62.30	19.99	5
	DAP	2.72	19.19	36.50	70.77	18.49	5
32(P2)	SP	3.15	20.91	37.00	66.60	21.83	6
	MAP	2.95	16.69	39.25	72.60	19.33	5
	DAP	3.55	19.28	45.00	77.50	29.99	8
40(P3)	SP	3.12	19.49	36.25	63.50	20.66	5
	MAP	3.15	17.82	41.25	76.50	22.66	6
	DAP	3.05	20.66	40.75	72.40	24.99	7
L.S.D at 0.05		N. S	4.8	N. S	N. S	1.39	

Hassan et al. (1990) on *Vigna Spp.*, ***El-Sawah et al. (1985)***, *Salem and El-Masri (1986)* and *El-Bana and Soliman (1994)* on *Vicia faba*. ***Mohamed et al. (1999)*** on cowpea reached to the same result, which indicated the role of P-fertilizer application on number of pods per plant.

With regard to the effect of phosphorus fertilizer source on number of pods per plant, data Table (5) showed that plants supplied with DAP gave significantly higher number of pods / plant as compared with other P-sources; SP and MAP only in the first season. However, no considerable variances were detected as for number of pods per plant in the second season. This result may be due to the stimulating effect of NH_4^+ on PO_4^{-3} uptake by plants supplied with DAP which increased plant growth and number of pods produced per plant.

Concerning with interaction effect of P-level within P-source on number of pods per plant, data Table (6) show that variances were significant in both seasons. Plants supplied with DAP at any P-levels (DAP x P_1, P_2 and P_3), or supplied with SP at P_3 gave the highest number of pods / plant as compared with the other treatments in both seasons. However, plants fertilized with SP within P_1, P_2 or P_3 gave higher and similar number of pods per plant not less than of those received DAP within all P-levels. i.e. the superiority of DAP as a source of P-fertilizer for common bean was more clear in the first season as compared with the other P-sources especially when DAP was added at 24 or 32 kg P_2O_5 / fed.

It is worth to mention that plants supplied with DAP at 32 kg P_2O_5 / fed gave higher plant growth, (Table, 2) and removed higher N, P and K from soil (Tables, 8, 10 & 12) therefore, produced higher number of fruits per plant.

4.1.3.c. Seed index 100-seeds wt. (g) as affected by level and / or source of P-application.

With regard to the effect of level of phosphorus fertilizer on seed index (100 seeds wt.), data Table (5) show that increasing level of P-fertilizer led to a significant differences in seed index, only on the second season. Whereas, increasing P-fertilizer level from 0, 24 up to 32 kg P_2O_5 / fed gradually and significantly improved weight of 100 seeds. However, increasing P-application level up to 40 kg P_2O_5 / fed did not increase seed index, as shown in both seasons. These results are in agreement with those obtained by ***Suryanarayana and Kumar (1981), Vidal et al. (1982), Gonzalez et al. (1985) and Abaza (1991)*** on beans, ***farag et al. (1987) and Hassan et al. (1990)*** on *Vigna Sp.*, ***El-Sawah et al. (1985)*** on *Vicia faba* and ***Eid*** and ***Mohamed (1989)*** on cauliflower, all mentioned that seed index was increased by P-application. On the other hand, ***Vieira (1989)*** on bean showed that seed index was not affected by P- application up to 100 kg P_2O_5 / ha.

Concerning with the effect of P-fertilizer source on seed index, data Table (5) show that plants supplied with DAP gave higher seed index in both seasons as compared with the other sources; SP and MAP, but variances were significant only in the second season. This result may be due to that DAP contain NH_4^{+} + PO_4^{-3} in one fertilizer which increased the uptake of both N, P and K in plant foliage and consequently in dry seeds as shown in Table (13).

This result is in agreement by ***Abd El-All (1999)*** on cauliflower who reported that seed index was increased in plants supplied with DAP or MAP as compared with SP fertilizer.

Regarding to the interaction effect of P-level within P-source on seed index, data Table (6) did not show any significant effect in this respect, in both seasons. This result may be due to that P-level or P-source affects on seed index separately.

4.1.3.d. Netting % as affected by level and / or source of P-application:

With regard to the effect of P-application level on netting %, data Table (5) show that increasing P-fertilizer level from 0 up to 24 and 32 kg P_2O_5 / fed led to a significant increase in netting % in the first and the second season, respectively. However, increasing P-level up to 40 kg P_2O_5 / fed did not result any significant increase in netting % as a general trend in both seasons as compared with 32 kg P_2O_5 / fed.

Concerning with the effect of P-fertilizer source on netting % , data Table (5) indicated that plants received DAP resulted higher netting % as compared with the other sources especially in the second season. Whereas, no significant differences in netting % due to P-source were detected in the first season.

Regarding the effect of interaction between P-level and P-source, it is evident also from data Table (6) that plants supplied with 32 kg P_2O_5 / fed as DAP gave higher netting % but variances failed to reach the level of significant, as shown in both seasons.

4.1.3.e. Dry seed yield per plant as affected by level and / or source of P-application:

Concerning with the effect of level of phosphorus fertilizer on dry seed yield per plant, data Table (5) show that increasing levels of P-fertilizer from 0, 24 up to 32 kg P_2O_5 / fed gradually and significantly increased dry seed yield per plant, as shown in both seasons. However, increasing of P-fertilizer level at 40 kg P_2O_5 / fed did not increase dry seed yield / plant as compared with 32 kg P_2O_5 / fed in both seasons. The superiority of such treatment (32 kg P_2O_5 / fed) on dry seed yield per plant may be attributed to its enhancing effect on plant flowering and fruit setting which increased number of pods per plant as well as improved seed index.

The favourable effect of increasing phosphorus application level on dry seed yield of legume plants is mainly due to its effect on improving plant growth, minerals uptake (N, P and K Table 13) which consequently improved dry seed yield and its components. These results are in agreement with that obtain by ***Mahatanya (1980) and Abd El-Hafez (1994)*** on bean who reported that dry seed yield / plant was increased by increasing P-application level up to 107 kg P_2O_5 / ha or 96 kg P_2O_5 / fed for each, respectively. Also, ***Farag et al. (1987)*** and ***Ali (2000)*** on cowpea and ***Salem and El-Masrri (1986)*** on *Vicia faba* pointed out to the favourable effect of P-application on dry seed yield per plant.

According to the effect of P-fertilizer source on dry seed yield per plant, data Table (5) show that plants fertilized with DAP produced higher dry seed yield per plant than those received SP or MAP, as a general trend in both seasons. The superiority of using DAP fertilizer on dry seed yield / plant as compared with the other sources may be referred to its favourable effect on plant growth, number of pods / plant and seed index and minerals uptake, especially N and P which increased dry seed yield per plant of plants fertilized with DAP. It is worth to mention that NH_4^+ and PO_4^{-3} are included together in one fertilizer (DAP) in the granulated form which may stimulate root proliferation of common bean plants in the early stages of plant growth. Obtained results agree with those of ***Rhoads***

(1991) on snap bean, ***Sharma and Mann (1973), Henmi et al. (1973) and Zaki et al. (1979)*** on tomato. Moreover, ***Abd El-All (1999)*** on cauliflower indicated that adding DAP as a source of P-application significantly increased seed yield of cauliflower as compared with SP or MAP.

Concerning with the interaction effect of P-level within P-source on dry seed yield per plant, data Table (6) show that increasing level of P-application from 0, 24 up to 32 kg P_2O_5 / fed within DAP increased dry seed yield / plant. Therefore, plant received 32 kg P_2O_5 / fed as DAP gave the highest significant dry seed yield /plant as compared with the other treatment, in both seasons. Although, increasing level of DAP at 40 kg P_2O_5 / fed decreased dry seed yield / plant than 32 kg P_2O_5 within DAP, but this treatment came in the second rank and gave higher dry seed yield / plant as compared with the other treatments. These results were true during both seasons. The superiority of using DAP at 32 kg P_2O_5 / fed could be referred to the favourable effect of this fertilizer as a moderate level on plant growth, flowering and fruit setting as well as the effect of NH_4^+ on N, PO_4^{-3} and K^+ uptake which improved yield components and consequently increased dry yield per plant. These results are in agreement with those obtained by ***Mahatanya (1980), Mahboob et al. (1984), 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 reported that dry seed yield / plant was increased by increasing phosphorus fertilizer rate up to 150 kg calcium super phosphate / fed.

4.1.3.f. Total dry seed yield per feddan as affected by level and / or source of P-application:

Concerning with the effect of P-application level on total dry seed yield / fed, data Table (5) show the same trend previously mentioned under dry seed yield per plant (4-1-3-e) i.e. data show that increasing level of P-fertilizer from 0, 24 up to 32 kg P_2O_5 / fed gradually and significantly increased total dry seed yield per feddan as shown in both seasons. However, increasing level of P-application from 32 up to 40 kg P_2O_5 / fed did not significantly increase total dry seed yield / fed, as shown in both seasons. This increment obtained in dry seed yield by using P_2 level ranged from 37.7 – 74.8% over the control and 16.87 – 21.65% over P1 level, as shown in 1998 and 1999 seasons, respectively. This increasing in seed yield may be due to the role of P on plant growth, minerals uptake and consequently on flowering and seed development, which increased number of pods per plant, seed index and consequently increased seed yield per plant and per feddan. These results are in agreement with ***Feitosa et al. (1980), Oliveira et al. (1982), Vidal et al. (1982), Frizzon et al. (1982), Gallo (1984), Manrique (1986), Prabhakar et al. (1986), Selim et al. (1986), Alt (1987), Chagas et al. (1987), Otabbong et al. (1991) and Abd El-Hafez (1994)*** all working on beans and found that total dry seed yield / fed were increased by increasing P-fertilizer level.

Other investigators working on legume crops, *Farag et al. (1987), Gajanan et al. (1990) and Hassan et al. (1990)* on cowpea **and** *Mallarino et al. (1991)* and *Rajabdandari (1992)* on soybean, all reported that P-application increased dry seed yield production.

Regarding with the effect of P-fertilizer source on total dry seed yield per feddan, it is clear from Table (5) that plants fertilized with DAP gave higher and significant dry seed yield per feddan as compared with the other sources; SP and MAP in both seasons. Therefore, DAP could be recommended as a good P-source for common bean as compared with the other two sources; SP and MAP. The superiority of DAP as a source of P-fertilizer may be due to that this fertilizer contains N in the ammonium form which encourage the uptake of PO_4^{-3} ***(Tisdale and Nelson, 975).*** According to the theory of ***Mengle and Kirkby (1982);*** NH_4^{+} acts as cations and PO_4^{-3} acts as anions, therefore when plants took up NH_4^{+} it needs to take up PO_4^{-3} in order to keep the anion cation balance in plant tissues. Such results are in harmony with those obtained by ***Abd El-All (1999)*** on cauliflower who reported that total dry seed yield / fed was increased by adding P-fertilizer source as DAP.

Concerning with the interaction effect of P-level within P-source on seed yield per feddan, data Table (6) show that plants supplied with 32 kg P_2O_5 / fed as DAP (P2 x DAP) gave similar and higher dry seed yield / feddan as compared with the other tested treatment as shown in both seasons. The superiority of using P_2 x DAP versus P_2 x SP reached 20.21– 37.40 % in dry seed yield per feddan i.e. that using 32 kg P_2O_5 as DAP increased dry seed yield per feddan with 20 – 37% as compared with using super phosphate fertilizer in the first and second season, respectively. Therefore, 32 kg P_2O_5 / fed with Diammonium phosphate (DAP) could be recommended for common bean nutrition under such field conditions in order to increase dry seed yield per feddan about 28.5% as an average for the two seasons.

Results on the favourable effect of using moderate P levels on common bean seed yield are in agreement with ***Feitosa et al. (1980)*** recommending 90 kg P_2O_5 / ha, ***Oliviera et al. (1982), Vidal et al. (1982)*** using 300-320 kg P_2O_5 / acre, ***Gallo (1984), Manrique (1986)*** recommending 100 Kg P_2O_5 / ha, ***Les and Stan (1984)*** using 150 kg P_2O_5 / ha. Moreover, ***Chagas et al. (1987) and Ottabang et al. (1991)*** reported that dry seed yield / fed was increased by increasing P-fertilizer level up to 150 kg SP / fed.

The superiority of using DAP on fruit yield of snap bean as compared with SP or OSP have been mentioned by ***Rhoads (1991).*** Results of dry seed yield per feddan are also agree with ***Abd El-All (1999)*** on Cauliflower who recommended using DAP at 60 kg P_2O_5 / fed to get the maximum seed yield of cauliflower. ***Zennat and Sharma (1990)*** on tomato found that adding DAP produced a significant increase in fruit yield by weight and number.

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4.1.4. <u>Chemical constituents of common bean plant foliage</u>:

4.a. Effect of P-level and / or source on N-content of plant foliage of common bean.

Data on N % and uptake of plant foliage; leaves, stem and total plant foliage as affect by level and / or source of phosphorus fertilizer are given in Tables (7, 8). Data on the effect of P-fertilizer level on plant foliage, data Table (7) show that increasing phosphorus fertilizer level from 0, 24 up to 32 kg P_2O_5 / fed led to a gradually and significantly increased N% and uptake of leaves, stem and total N-uptake / plant. This trend was pronounced and significant in both seasons. Whereas, fertilizing common bean plants with 40 kg P_2O_5 / fed did not significantly increase N % of leaves and stem than 32 kg P_2O_5 / fed as a general trend in both seasons. With respect to total N-uptake of plant foliage, results showed the same trend in the first season. However, adding 40 kg P_2O_5 / fed significantly increased total N-uptake of plant foliage in the second season as compared with the other levels.

Such increment in N-uptake could be referred to the simulative role of P on root proliferation and plant growth ***(Tisdale & Nelson, 1975)*** **in** turn may which increase plant growth expressed with dry matter content per plant and consequently increase N, P and K uptake. These result are in agreement with those of ***Mack (1983)*** on snap bean who mentioned that higher NPK rates (224 – 296 – 184) kg / ha, respectively tended to increase nitrogen concentration in

Table (7) N% and uptake of plant foliage of common bean as affected by level or source of P-application during 1998 &1999.

Treatments	N %		N –uptake(mg/plant)			N %		N- uptake(mg/plant)		
	leaf	stem	leaf	Stem	total	leaf	stem	Leaf	stem	total
kg p_2O_5/fed.	First season (1998)					Second season (1999)				
0 (p0)	2.340	1.633	234.00	81.66	315.66	2.260	1.563	235.66	81.00	316.66
24 (p1)	2.526	1.893	253.00	97.66	350.66	2.393	1.606	255.00	90.66	345.66
32 (p2)	2.800	2.063	275.33	111.66	386.99	2.730	2.170	281.00	110.33	391.33
40 (p3)	2.715	1.841	280.00	113.34	393.34	2.670	1.979	281.33	122.33	403.66
L.S.D at 0.05	0.04	N. S	10.400	4.83	12.10	0.09	0.041	3.68	1.46	12.55
P-source	First season (1998)					Second season (1999)				
SP	2.680	1.787	260.750	94.25	355.00	2.527	1.760	260.50	97.25	357.75
MAP	2.546	1.630	257.500	102.25	359.750	2.497	1.790	261.75	79.50	341.25
DAP	2.560	2.156	263.500	106.75	370.250	2.515	1.939	267.50	108.50	376.00
L.S.D at 0.05	N. S	0.10	N. S	4.58	8.15	N. S	0.039	2.97	3.94	12.11

snap bean leaves. Also, ***Abd El-All (1999)*** on cauliflower who found that increasing level of P-application significantly increased total N, P and K uptake and accumulation in curds.

As for, the effect of P-source on N% and its uptake of plant foliage, data Table (7) show that plants fertilized with DAP contained higher N% and uptake in stem and total plant foliage as compared with that of other sources; SP or MAP, as a general trend in both seasons. However, N% in leaves was not considerably differed due to P-source in both seasons. This result is in harmony with those obtained by ***Abd El-All (1999)*** on cauliflower who found that adding phosphorus as MAP or DAP gave higher curd content of total N% and uptake as compared with SP fertilizer.

Regarding with the interaction effect of P-level within P-source on N-content of plant foliage, data Table (8) show that plants received DAP at 32 kg P_2O_5 / fed had the highest significantly increased of N-uptake, as shown in both seasons. Whereas, N% and its uptake in leaves were significant increased in the second season only. On the other hand, the lowest N-content of plant foliage was found in plants, which not fertilized with phosphorus $(PO_4)^{-3}$ with any source.

Table (8) N% and uptake (mg/plant) of plant foliage of common bean as affected by level within source of P-application during 1998 &1999.

Treatments		N%		N- uptake (mg/plant)			N%		N- uptake (mg/plant)		
kg p_2O_5/fed.	P-source	Leaf	Stem	leaf	Stem	Total	leaf	Stem	leaf	Stem	Total
		First season(1998)					Second season(1999)				
0 (Cont.)	SP	2.46	1.78	246	89.00	335	2.38	1.71	241	81.00	322
	MAP	2.32	1.54	232	77.00	309	2.24	1.47	237	80.00	317
	DAP	2.24	1.58	224	79.00	303	2.16	1.51	229	82.00	311
24 (P1)	SP	2.70	1.86	241	90.00	331	2.40	1.79	246	83.00	329
	MAP	2.48	1.56	248	98.00	346	2.36	1.49	250	91.00	341
	DAP	2.40	2.26	270	105.0	375	2.42	1.54	269	98.00	367
32 (P2)	SP	2.70	1.90	270	98.00	368	2.62	1.82	275	109.00	384
	MAP	2.82	1.72	268	106.00	374	2.72	2.19	273	89.00	362
	DAP	2.88	2.57	288	131.00	419	2.85	2.50	295	133.00	428
40 (P3)	SP	2.86	1.61	286	100.00	386	2.71	1.72	280	116.00	396
	MAP	2.56	1.70	282	128.02	410	2.67	2.01	287	130.00	417
	DAP	2.72	2.21	272	112.00	384	2.63	2.21	277	121.00	398
L.S.D at 0.05		N. S	0.20	N.S	9.16	15.45	0.01	0.09	5.95	7.88	16.40

4.b. Effect of P-level and / or P-source on P-content of plant foliage of common bean.

Data on the effect of P-application level on P % and uptake of plant foliage are given in Table (9). Such data show that increasing phosphorus fertilizer level from 0, 24 up to 32 kg P_2O_5 / fed led to gradually and significantly increased P% and P-uptake in leaves and stem as well as total P-uptake of plant foliage in both seasons. Heavier application of phosphorus fertilizer up to 40 kg P_2O_5 / fed did not increase P% or P-uptake of leaves and stem as compared with that of plants received 32 kg P_2O_5 / fed, as a general trend in both seasons. This result reflects the favourable effect of P-application on N and P- uptake, which encouraged plant growth and increased nutrients accumulation in plant organs. These results are in agreement with those results obtained by ***El-Sharkawy et al. (1990)*** on peas who indicated that P-application up to 54 kg P_2O_5 / fed increased phosphorus content of leaves.

According to the effect of P-fertilizer source on P% and uptake of plant foliage, data Table (9) show that plants supplied with DAP gave higher P% and uptake in leaves, stem and total plant foliage as compared with the other sources; SP or MAP. This trend was true in both seasons, except for P % of stem which was not significantly affect due to P-fertilizer sources. Such increment in N and P content by adding DAP may be due to the encourage effect of the associated ammonium ions on P-uptake and consequently on N and P content of plant organs. This result is in agreement with those results obtained by

Table (9) P% and uptake (mg/plant) of plant foliage of common bean as affected by level or source of P-application during 1998 &1999

Treatments	P%		P-uptake (mg/plant)			P%		P-uptake (mg/plant)		
	leaves	stems	leaves	stems	Total	leaves	stems	leaves	stems	Total
kgP_2O_5/fed.	First season (1998)					Second season (1999)				
0 (p0)	0.225	0.208	15.90	8.15	24.05	0.218	0.203	13.65	7.15	20.80
24 (p1)	0.237	0.233	18.96	9.30	28.28	0.230	0.225	16.71	8.30	25.01
32 (p2)	0.260	0.269	22.53	11.60	34.13	0.254	0.263	20.28	10.60	30.88
40 (p3)	0.256	0.259	22.18	11.81	33.99	0.248	0.253	19.93	11.15	31.08
L.S.D at 0.05	0.009	0.011	1.37	0.27	1.33	0.004	0.009	0.090	0.53	0.60
P-source										
SP	0.235	0.241	19.70	9.425	29.12	0.228	0.234	17.45	8.425	25.875
MAP	0.236	0.241	18.51	10.08	28.59	0.229	0.235	16.26	9.087	25.347
DAP	0.262	0.245	21.47	11.13	32.60	0.255	0.239	19.22	10.387	29.607
L.S.D at 0.05	0.01	N. S	1.42	1.04	1.31	0.005	N. S	0.57	0.42	0.41

Sharma and Mann (1973) on tomato and *Abd El-All (1999)* on cauliflower.

With regard to interaction effect of P-level within P-source on P % and uptake of leaves, stem and total plant foliage, data table (10) indicated that there was a significant interaction in this respect of both seasons. Plants received DAP at 32 kg P_2O_5 / fed had the highest significant P-uptake in leaves, stem and total plant foliage. This increasing in P-uptake may be referred to the enhancing effect of NH_4^+ on PO_4^{-3} uptake which increased growth of plants supplied with DAP. This explanation agrees with ***Mengle and Kirkby (1982).*** On the other hand, the lowest P % and uptake were found in control treatment when no P-fertilizer was added.

4.c. Potassium content of plant foliage as affected by level and / or source of P-fertilizer:

Data on the effect of phosphorus fertilizer level on K% and uptake of plant foliage are illustrated in Table (11). Results show that increasing P-application level from 0, 24 up to 32 kg P_2O_5 / fed led to a significant increase K% and uptake of plant organs; leaves, stem and total plant foliage. Increasing P-fertilizer level from 32 up to 40 kg P_2O_5 / fed did not increase K- uptake of plant foliage as a general trend for both seasons. The favourable effect of P-application on K-uptake may be referred to the encourage of N, P and K uptake which consequently increased plant growth of plant received optimum P-fertilizer level; P_2

Table (10) P% and uptake (mg/plant) of plant foliage of common bean as affected by levels within sources of P-application during 1998 & 1999.

Treatments		P%		P-uptake(mg/plant)			P%		P-uptake(mg/plant)		
KgP_2O_5/fed.	P-source	leaves	stems	leaves	stems	Total	leaves	stems	leaves	stems	Total
		First season(1998)					Second season(1999)				
0 (Cont.)	SP	0.212	0.216	18.20	7.00	25.20	0.205	0.211	15.95	6.00	21.95
	MAP	0.214	0.200	14.30	8.35	22.65	0.207	0.195	12.05	7.35	19.40
	DAP	0.249	0.210	15.20	9.10	24.30	0.242	0.205	12.95	8.10	21.05
24 (P1)	SP	0.230	0.234	18.80	10.30	29.10	0.223	0.226	16.55	9.30	25.85
	MAP	0.224	0.239	17.30	8.35	25.65	0.217	0.231	15.05	7.35	22.40
	DAP	0.258	0.227	20.80	9.25	30.05	0.251	0.219	18.55	8.25	26.80
32 (P2)	SP	0.250	0.241	20.60	10.70	31.30	0.243	0.237	18.35	9.70	28.05
	MAP	0.259	0.279	20.00	9.70	29.70	0.252	0.270	17.75	8.70	26.45
	DAP	0.273	0.288	27.00	14.40	41.40	0.269	0.283	24.75	13.40	38.15
40 (P3)	SP	0.251	0.273	21.20	9.70	30.90	0.244	0.264	18.95	8.70	27.65
	MAP	0.247	0.249	22.45	13.95	36.40	0.240	0.245	20.20	12.95	33.15
	DAP	0.270	0.255	22.90	11.80	34.70	0.260	0.251	20.65	11.80	32.45
L.S.D at 0.05		N. S	N. S	2.85	2.09	2.91	0.01	N. S	1.140	0.85	1.08

Table (11): K% and uptake (mg/plant) of plant foliage of common bean as affected by level or source of P application during 1998 &1999.

Treatments	K%		K-uptake (mg/plant)			K%		K-uptake (mg/plant)		
	leaves	stems	leaves	stems	Total	leaves	stems	leaves	stems	Total
$kgP_2 0_5$/fed.	First season (1998)					Second season (1999)				
0 (p0)	1.727	2.415	172.8	231.40	404.20	1.757	2.219	160.3	247.73	408.03
24 (p1)	2.108	2.838	225.2	228.98	454.18	2.147	2.798	212.7	255.13	467.83
32 (p2)	2.803	3.325	282.6	324.40	607.00	2.478	3.201	280.3	301.66	581.96
40 (p3)	2.513	3.145	259.2	315.92	575.12	2.882	2.958	246.7	293.40	540.10
L.S.D at 0.05	0.20	0.17	20.6	40.0	33.00	0.050	0.050	1.5	1.80	25.0
P- source	First season (1998)					Second season (1999)				
SP	2.396	3.104	240.1	310.23	550.33	2.172	3.071	238.2	296.25	534.45
MAP	1.992	2.702	205.0	248.61	453.61	2.274	2.634	189.5	250.85	440.85
DAP	2.473	2.980	259.8	311.69	571.49	2.502	2.678	247.2	274.97	522.17
L.S.D at 0.05	0.370	0.190	2.25	1.85	21.1	0.300	0.260	1. 6	3.0	12.0

level (32 kg P_2O_5 / fed).

This result is in harmony with those of *Abd El-Hafez (1994)* on bean who found that the maximum concentration and uptake of N, P and K was obtained by application of phosphorus level up to 96 kg P_2O_5 / fed.

With regard to the effect of P-fertilizer source on K% and uptake of plant foliage, data Table (11) show that plants fertilized with DAP or SP had higher K% and uptake of leaves, stem and total plant foliage than those received MAP, as a general trend in both seasons.

Concerning with the interaction effect of P-application level within source on potassium content of plant foliage, data Table (12) show that plants received 32 kg P_2O_5 / fed as DAP or SP gave the highest significant content of K% and its uptake in leaves, stem and total plant foliage in both seasons except for K% in leaves in the first season when variances between treatments were not significant.

4.d. Effect of level and / or source of P-fertilizer on N, P and K content of common bean dry seeds.

Data on the effect of phosphorus fertilizer level on N, P and K % and its uptake of dry seeds are given in Table (13). Such data show that increasing P-fertilizer level from 0, 24 up to 32 kg P_2O_5 / fed led to a significant increase NPK content of dry seeds. Moreover, increasing P-fertilizer

Table (12): K% and uptake (mg/plant) of plant foliage of common bean as affected by levels within source of P- application during 1998 &1999.

Treatments		K%		K-uptake (mg/plant)			K%		K-uptake (mg/plant)		
P-level	P-source	leaves	stems	leaves	stems	Total	Leaves	stems	leaves	stems	Total
		First season (1998)					Second season (1999)				
Cont. (p0)	SP	1.740	2.990	174.2	267.7	451.9	1.820	2.880	161.7	279.2	440.9
	MAP	1.825	1.625	182.7	161.5	344.2	1.833	1.615	170.2	221.5	391.7
	DAP	1.610	2.630	161.5	265.0	426.5	1.618	2.162	149.0	242.5	391.5
24 (P1)	SP	1.865	3.130	187.0	323.0	510.0	1.873	3.030	217.0	300.5	517.5
	DAP	2.590	2.630	259.2	301.7	560.9	2.610	2.620	246.6	245.2	491.8
	MAP	1.870	2.756	229.5	242.2	471.7	1.960	2.746	174.5	219.7	394.2
32 (P2)	SP	3.050	3.215	306.0	348.5	654.5	2.060	3.205	293.5	306.0	599.5
	MAP	2.295	3.270	187.0	272.0	459.0	2.303	3.000	205.0	260.0	471.0
	DAP	3.063	3.490	355.0	352.7	707.7	3.073	3.400	342.5	333.0	675.5
40 (P3)	SP	2.930	3.080	293.2	301.7	594.1	2.938	3.170	280.7	304.8	585.5
	MAP	1.980	2.182	321.0	318.7	539.7	3.000	3.175	208.5	296.2	504.7
	DAP	2.630	3.172	263.6	327.3	590.9	2.710	2.530	251.0	279.2	530.2
L.S.D at 0.05		N. S	0.38	45.0	37.0	41.1	0.610	0.520	3.2	6.1	27.0

Table (13): N, P and K and uptake (g/plant) of common bean dry seeds as affected by levels or source of P-application during 1998 &1999.

Treatments		N, P and K %			N, P and K-uptake (g/plant)			N, P and K %			N, P and K-uptake (g/plant)		
		N	P	K	N	P	K	N	P	K	N	P	K
Kgp2o5/fed.	P-sources	First season (1998)						Second season (1999)					
0	(p0)	2.503	0.409	1.230	2.403	0.683	2.550	2.713	0.488	1.864	2.713	0.797	2.711
24	(p1)	2.610	0.444	1.397	2.618	0.740	3.016	3.000	0.554	1.920	3.046	0.924	2.825
32	(p2)	3.163	0.503	1.818	2.963	0.839	3.470	3.440	0.629	2.164	3.560	1.061	3.335
40	(p3)	3.033	0.476	1.718	3.153	0.794	3.428	3.326	0.632	2.255	3.326	1.041	3.415
L.S.D at 0.05		0.20	0.009	0.18	0.15	0.026	0.49	0.170	0.004	0.130	0.17	0.024	0.23
P-source													
SP		2.945	0.437	1.597	2.678	0.729	3.070	3.040	0.556	1.983	3.140	0.924	2.973
MAP		2.817	0.463	1.431	2.817	0.772	3.123	3.035	0.539	1.934	3.055	0.889	2.800
DAP		2.720	0.474	1.594	2.857	0.791	3.155	2.285	0.632	2.235	3.290	1.054	3.441
L.S.D at 0.05		0.016	N. S	0.150	0.100	0.050	N. S	0.080	0.019	0.06	0.120	0.02	0.090

level from 32 up to 40 kg P_2O_5/ fed. did not significant increase in NPK content of dry seeds. This result reflect the favourable effect of P-application on N, P and K uptake which encouraged plant growth and increased accumulation in plant organs; leaves, stem and seeds. This increment could be also referred to the increasing in dry seed yield of plants supplied with P_2 level (32 kg P_2O_5 / fed). Results are in agreement with those of ***Eid (1991)*** on bean who indicated that increasing NP-rate up to 60 kg N within 48 kg P_2O_5 /fed. proved to be significantly effective in increasing the content of N, P and K in bean seeds. Moreover, ***Shafshak (1991), Abd El-Hafez (1994)*** on bean, ***Hamdi et al. (1966), Bains (1967), Eweida*** **and** ***Metwally (1975), Omar (1980)*** **and** ***farrag et al. (1992)*** on broad bean, ***Ali (2000)***on pea and ***Abd El-All (1999)*** on cauliflower, all supported the role of increasing P-fertilizer on NPK uptake of plant foliage and seeds. On the other hand, ***Midan et al. (1980), Lauer (1982)*** **and** ***Vieira (1986)*** on beans all found that increasing soil application of phosphorus fertilizer up to 30 or 100 kg P_2O_5 / ha decreased seed N- content.

According to the effect of P-fertilizer source on N, P and K% and its uptake of dry seeds, data Table (13) show that plants supplied with DAP contained higher P and K% and its uptake of seeds than in those supplied with MAP or SP, especially in the second season. However, plants supplied with DAP or MAP resulted similar N, P and K uptake as compared with SP with respect to N and P uptake of seeds in the first season. Such increment in N, P and K content by DAP may be due to the encouraging effect of the associated ammonium ions on P-uptake and consequently on N, P and K content. This result is in harmony with those of *Abd El-All (1999)* on cauliflower who found that adding phosphorus as MAP or DAP gave higher N, P and K content than that of other source; SP or GTSP.

Concerning with the interaction effect of P-fertilizer level within P-source on N, P and K content of dry seeds, data Table (14) show that N, P and K% and its uptake were significantly differed due to the used phosphorus treatments, especially in the second season. Plants supplied with DAP at 32 kg P_2O_5 / fed had higher N, P and K content of seeds than of the other treatments as shown in the second season. However, P and K content (% and uptake) of seeds were not significantly differed due to level within source of phosphorus treatments. Generally, results on N, P and K% and uptake reflect the superiority of DAP as compared with SP or MAP at P_2 level. This result is in agreement with those results obtained by *Saleh et al. (1980)*, *Hassan* and *Morsy (1986)* and *Mohamed et al. (1999)* on cowpea.

4.2. Second Experiment:

Effect of time and frequency of P-application on vegetative growth, yield and quality of common bean (*Phaseolus vulgaris* L.)

Table (14): N, P and K percentage and uptake (g/plant) of common bean dry seed as affected by level within source of P- application during 1998 &1999.

Treatments		N,P and K percentage			N,P and K uptake(g/plant)			N,P and K percentage			N,P and K uptake(g/plant)		
P-level	P-source	N	P	K	N	P	K	N	P	K	N	P	K
		First season (1998)						Second season (1999)					
Cont. (p0	SP	2.700	0.414	1.400	2.400	0.690	2.805	2.740	0.543	1.860	2.740	0.855	2.740
	MAP	2.650	0.418	1.020	2.650	0.697	2.295	2.480	0.450	1.780	2.480	0.750	2.570
	DAP	2.160	0.397	1.270	2.160	0.662	2.550	2.920	0.472	1.950	2.920	0.787	2.825
24 (P1	SP	2.710	0.423	1.440	2.435	0.705	2.890	3.100	0.559	1.950	3.240	0.933	2.910
	MAP	2.720	0.450	1.140	2.720	0.750	3.060	2.620	0.520	1.820	2.620	0.867	2.655
	DAP	2.400	0.459	1.610	2.700	0.765	3.100	3.280	0.583	1.980	3.280	0.972	2.910
32 (P2	SP	3.170	0.423	1.770	2.710	0.705	3.017	3.240	0.564	2.040	3.500	0.940	3.080
	MAP	3.020	0.522	1.820	2.880	0.870	3.655	3.502	0.582	1.910	3.580	1.007	2.825
	DAP	3.300	0.566	1.860	3.300	0.942	3.740	3.580	0.742	2.540	3.600	1.237	4.100
40 (P3	SP	3.200	0.490	1.780	3.170	0.817	3.570	3.080	0.559	2.080	3.080	0.970	3.165
	MAP	2.880	0.463	1.740	3.020	0.772	3.485	3.540	0.604	2.220	3.540	0.932	3.150
	DAP	3.020	0.477	1.630	3.270	0.794	3.230	3.360	0.733	2.460	3.360	1.222	3.930
L.S.D at 0.05		0.320	N. S	N. S	0.200	N. S	N. S	0.160	0.380	0.130	0.250	0.046	0.190

4.2.1. Effect of time and frequency of P-application on vegetative growth:

The effect of time and frequency of P-application on plant height, number of leaves and branches per plant, stem diameter and fresh and dry weight / plant are presented in Table (15).

Data on the effect of time and frequency of P-fertilizer on plant height, number of branches / plant and stem diameter, data Table (15) did not show any significant effect in this respect in both seasons. It means that adding super phosphate fertilizer at 1, 2 or 3 times had no significant effect on these three parameters of common bean vegetative growth. Although, data showed a tendency towards the improvement in plant height, number of branches and stem diameter by splitting P-fertilizer at 2 or 3 split applications, but variances failed to reach the level of significant.

With respect to number of leaves / plant, data Table (15) show that plants supplied with P at 3-applications (50 + 100 + 50 kg SP / fed) produced higher number of leaves per plant than the other treatments. This trend was true and significant in both seasons. The role of P on cell energy and root proliferation ***(Ohlrogge, 1962)*** may explain the encourage effect of P-application on plant growth especially number of leaves / plant. Results are in confirmation with ***Zaki et al. (1979)*** on tomato and ***Abd El-All (1999)*** on cauliflower who found that 3- split

Table (15) Effect of time and frequency of superphosphate application on vegetative growth of common bean during 1998 & 1999.

Treatments kg SP fed.	Plant height (cm)	No. of leaves /plant	No. of branches /plant	Stem diameter (cm)	Fresh wt. g /plant	Dry wt. g/plant	Plant height (cm)	No. of leaves /plant	No. of branches /plant	Stem diameter (cm)	Fresh wt. g /plant	Dry wt. g/plant
	First season 1998						Second season 1999					
Control	43.95	16.62	7.62	0.78	84.77	21.19	35.34	11.30	7.87	0.54	60.10	15.02
200	42.62	16.22	7.62	0.72	100.83	25.20	36.90	12.17	8.27	0.51	64.45	16.11
50+150	45.47	15.28	8.12	0.75	105.80	26.45	39.06	11.89	8.41	0.53	71.96	17.99
100+100	45.97	15.37	8.47	0.72	110.48	27.62	41.05	13.80	8.67	0.48	73.60	18.40
100+25 (S) +100+25 (S)	46.22	16.65	8.72	0.74	114.78	28.69	41.32	15.10	8.90	0.50	73.80	18.45
50+100+50	45.97	17.15	9.62	0.75	135.70	33.92	43.87	13.87	9.10	0.58	79.70	19.92
L.S.D at 0.05	N S	0.38	N S	N S	15.44	3.80	N. S	1.1	N. S	N. S	4.82	0.26

applications of P-fertilizer increased number of cauliflower leaves as compared with that of plants supplied with P at 1 or 2 times.

Concerning with the effect of time and frequency of P-fertilizer on fresh and dry weight per plant, data Table (15) show that split application of P-fertilizer at three times led to a higher and significant increase in total fresh and dry weight / plant than those received all P-fertilizer at one or two times or the control. This trend was true in both seasons. Moreover, adding P-fertilizer at two split applications showed a higher fresh and dry weight per plant than those received P at one dose after germination, but variances were only significant in the second season. This result may be due to that adding P-fertilizer at one time increase the chance of P-fixation with soil which decreased the availability of P through the season. On the other hand, adding P-fertilizer at 2 or 3 split applications will increase the available phosphorus through the growing season, which consequently increase P-uptake by plant roots all over the season. This result is in agreement with those results obtained by *Abd El-All (1999)* on cauliflower who indicated that adding phosphorus fertilizer at 3-split applications resulted the largest fresh and dry weight / plant as compared with plants supplied with P- at one or two applications.

4.2.2. Dry seed yield and its components as affected by time and frequency of P-application:

The effect of time and frequency of P-application on dry seed yield of common bean and its components; number of seeds / pod, number of pods / plant, seed index (100 – seeds weight), netting percentage and dry seed yield / plant as well as dry seed yield / fed. are given in Table (16).

Data on the effect of time and frequency of P-application on number of seeds / pod, (Table, 16) did not show any significant differences due to times of P-application, as shown in both seasons. This result may be due to that number of seeds per pod is a genetic character less affected by ecological factors such phosphorus fertilizer treatment under this study.

Regarding with the effect of time and frequency of P-application on number of pods / plant, data Table (16) showed that number of pods / plant were significantly increased in plants received P at 3-times (50 + 100 + 50 kg SP / fed) as compared with the other used treatments. This result was clear in both seasons of 1998 & 1999. The favourable effect of splitting SP fertilizer on number of pods / plant may be referred to the improvement of plant growth (Table, 15) and NPK nutrients uptake (Tables, 17, 18 and 19) when SP fertilizer was added at 3-split doses; 50 kg SP at pre-planting + 100 kg at germination stage + 100 kg SP at flowering stage.

Table (16) Effect of time and frequency of superphosphate application on dry seed and its quality of common bean during 1998 & 1999.

Treatments Kg SP/fed.	No. of Seeds /pod	No. of pods /plant	Seed index 100-seed/ g	Netting %	Seed yield g/plant	Seed Yield Kg/fed.	No. of Seeds /pod	No. of pods /plant	Seed index100 -seed/ g	Netting %	Seed yield g/plant	Seec Yielc kg/fec.
	First season 1998						Second season 1999					
Control	3.33	17.08	47.50	71.20	26.79	765.475	2.70	15.25	36.25	62.30	13.91	397.6[illegible]2
200	3.20	19..21	47.75	72.40	29.33	838.094	3.00	16.70	37.66	62.70	18.37	524.9[illegible]
50+150	3.40	20.35	48.00	73.00	31.74	907.142	3.20	17.60	40.00	65.80	20.47	592.85[illegible]
100+100	3.26	20.51	48.00	73.20	31.99	914.285	3.15	18.47	41.25	65.49	22.16	633.3[illegible]
100+25 (S)+ 100+25(S)	3.17	21.39	48.25	73.80	32.50	919.571	2.65	20.56	41.65	69.00	25.04	686.9[illegible]
50+100+50	3.60	23.30	50.00	74.60	36.33	1038.09	3.50	23.00	45.31	79.60	29.54	844.[illegible]
L.S.Dat 0.05	N. S	1.18	N. S	N. S	1.87	51.86	N. S	1.45	2.14	9.07	4.87	139.[illegible]

Concerning with the effect of time and frequency of P-fertilizer on seed index (weight of 100 seeds), data Table (16) show that plants received SP at 3-split applications gave a significant increase in seed index as shown in the second season. Although, the same trend was remarked in the first season, but variances failed to be significant.

According to netting %, data (Table, 16) show that plants received P at 3-split applications gave higher netting % than the other treatments, but variances were significant only in the second season.

With regard to the effect of time and frequency of P-fertilizer on dry seed yield per plant, data Table (16) show that adding SP at 3-split applications gave higher and significant increase in total dry seed yield per plant than those received all P-application at one or two times or the control. Moreover, adding SP fertilizer at two times results higher dry seed yield than adding SP at one time after germination. This trend was true in both seasons. This result may be referred to that 3-split applications led to more available P-fertilizer for plant uptake all over the season i.e. when P-requirements were added at one time it gives more chance for P-fixation and transformation to the unavailable form. This explanation agrees with ***Tisdale and Nelson (1975) and Zaki et al. (1979) and Abd El-All (1999).***

Regarding with the effect of time and frequency of P-application on dry seed yield (kg/fed), data Table (16) show the same trend of dry seed yield / plant i.e. that plants supplied with P at 3-split applications significantly produced higher total dry seed yield per feddan as compared with those supplied with P at 2-split applications or when all P-fertilizer was added at one time in a descending order. Whereas, the lowest dry seed yield was obtained when plants did not receive any P-fertilizer (control) followed by those received all P-fertilizer at one time; 200 kg SP / fed. However, plants received P at 2 times (50 kg SP + 150 kg SP / fed or 100 kg + 100 kg SP with or without elemental sulphur application) showed a medium values between those of plants received P-fertilizer at one or three times. This trend was true in both seasons. This increase in dry seed yield (kg / fed) of common bean by adding SP fertilizer at 3-times could be referred to the increase in number of pods / plant, seed index which increased dry seed yield per plant and consequently per feddan. The improvement in plant growth, nutrients uptake, yield components of plants supplied with super phosphate at 3-split times; 50 kg SP at pre-planting, 100 kg SP at germination and 50 kg SP at flowering stage was clear in both seasons and reflected on higher dry seed yield per plant as well as per feddan.

Data Table (16) showed that adding elemental sulphur at 25 kg S at two times with SP [100 kg SP + 25 kg (S) + 100 kg SP + 25 kg (S)] did not increase seed yield of common bean as compared with plants supplied with SP two time without sulphur.

Obtained results are in confirmation with those of *Dzhafarova and Ibrugimov (1973), Henmi et al. (1973) and Zaki et al. (1979)* on tomato *and Abd El-All (1999)* on cauliflower who recommended the split application of P at 2 or 3 times to get higher total yield. Moreover, adding SP fertilizer at 3-split applications led to more available P for plant uptake allover the season as shown in Table (18) i.e. when P-requirement was added at one or two times it gave more chance for P-fixation and transformation to the unavailable form. This explanation agrees with that obtained by *Tisdale and Nelson (1975), Zaki et al. (1979) and Abd El-All (1999).*

4.2.3. Chemical constituents of common bean plant foliage:

4.2.3.a. Effect of time and frequency of P-application on N-content of plant foliage:

Data on N% and its uptake of leaves, stem and total plant foliage are given in Table (17) such data on the effect of time and frequency of super phosphate application on N% and its uptake in plant foliage show that adding super phosphate fertilizer at 3-split applications gave higher N% and N-uptake in leaves, stems and total plant foliage than in case of 2-split applications or when all P-fertilizer was added at one time. This trend was true and significant in both seasons except for N% and its uptake in stem was

Table (17): N% and uptake (mg /plant) of plant foliage of common bean as affected by time and frequency of superphosphate fertilization during 1998 & 1999.

Treatments Kg SP/fed.	N%		N-uptake (mg/plant)			N%		N-uptake (mg/plant)		
	Leaves	Stems	Leaves	Stems	Total	Leaves	Stems	Leaves	Stems	Total
	First season 1998					Second season 1999				
Control	2.12	1.46	212.00	73.00	285.00	2.20	1.40	192.50	68.50	260.50
200	2.18	1.56	218.00	78.00	296.00	2.23	1.60	199.50	73.50	273.00
50+150	2.26	1.56	227.00	78.00	305.00	2.36	1.65	207.00	74.00	281.00
100+100	2.32	1.62	232.00	81.00	313.00	2.44	1.72	211.00	76.50	287.50
100+25(S)+100+25(S)	2.40	1.62	240.00	83.00	323.00	2.55	1.80	220.00	78.50	298.50
50+100+50	2.50	1.62	250.00	85.50	335.50	2.70	1.93	230.00	81.00	311.00
L.S.Dat 0.05	0.15	N. S	16.550	N. S	13.92	0.15	0.28	13.78	3.75	3.63

significant in the second season only. This result may be referred to that adding P at 3-split applications; 50 + 100 + 50 kg P_2O_5 / fed at soil management, germination time and flowering time, respectively led to more P and N uptake. It seams that high available HPO_4^{-3} activate NH_4^+ uptake especially N was added as $(NH_4)_2SO_4$ fertilizer. This explanation agrees with ***Kirkby and Mengel (1967), Mengel and Kirkby (1982)*** and ***Tisdale*** and ***Nelson (1975)*** who indicated that plants always keep the anion cation balance in plant tissues i.e.when plants took up high HPO_4^{-3} they should balance these anion by removing high NH_4^+ cations. This result is also in agreement with those results obtained by ***Abd El-All (1999)*** on cauliflower who indicated that phosphorus fertilizer at 3-times increased N% and its uptake as compared with P-application at 1 or 2 times.

4.2.3.b. Effect of time and frequency of P application on P-content of plant foliage:

Data on the effect of super phosphate fertilizer on P% and its uptake of plant foliage (Table, 18) indicated that adding phosphorus fertilizer at 3-split applications resulted higher P% and its uptake in both leaves, stems and total plant foliage as compared with that of plants received P at one or two split applications. Moreover, adding elemental sulphur at 50 kg S / fed at two split applications with SP fertilizer slightly increased P-uptake of plant foliage (Table, 18). These results were true and significant in both seasons. The improvement in P-uptake by splitting SP fertilizer could be referred to the high available PO_4^{-3} in

Table (18): P% and uptake (mg /plant) of plant foliage of common bean as affected by time and frequency of superphosphate fertilization during 1998 & 1999.

Treatments kg SP/fed.	P%		P-uptake (mg / plant)			P%		P-uptake (mg / plant)		
	Leaves	Stems	Leaves	Stems	Total	Leaves	Stems	Leaves	Stems	Total
	First season 1998					Second season 1999				
Control	0.250	0.168	15.80	5.60	21.40	0.246	0.163	13.30	4.60	17.90
200	0.225	0.207	17.00	6.90	23.90	0.250	0.202	14.50	5.90	20.40
50+150	0.259	0.210	17.30	7.00	24.30	0.252	0.205	14.80	6.00	20.80
100+100	0.237	0.232	17.60	7.75	25.35	0.264	0.227	15.10	7.75	22.85
100+25(S)+100+25(S)	0.264	0.232	20.30	7.75	28.05	0.270	0.243	17.80	8.00	25.80
50+100+50	0.314	0.273	31.40	9.10	40.50	0.296	0.268	28.50	9.10	37.60
L.S.D at 0.05	0.03	N. S	3.80	0.69	3.63	0.01	0.008	0.63	0.78	81

soil which consequently led to a high P-uptake of plants supplied with super phosphate fertilizer at three split applications. On the other hand, plants supplied with P at one dose contained as compared with P-content of plant supplied with SP at two times (100 + 100 or 50 + 150 kg SP / fed) less P% and uptake (mg / plant, Table 18) due to the fixation of P on soil complex and it conversion to the unavailable form especially soil pH was slightly high (pH 7.5). This result is in agreement with ***Abd El-All (1999)*** who found that splitting P-fertilizer at 3-split application led to a higher P-content of cauliflower plants.

Moreover, the slight improvement in P-uptake by S-application could be referred to the acidic effect of S on soil reacuon which may increase the available phosphorus in the soil which consequently increased P accumulation in plant tissues. This result agrees with those ***Aulakh and Pasricha (1977), Barkas (1981)*** on bean and ***Gabal (1975)*** on tomato who indicated that S application improved P-uptake.

4.2.3.c. Effect of time and frequency of P-application on K-content of plant foliage:

Data (Table, 19) on the effect of time and frequency of super phosphate application on K% and its uptake of plant foliage, show that adding phosphorus fertilizer at 3-split application gave higher K% and uptake of leaves, stem and total plant foliage than in case of 2-split applications or when all P fertilizer was added at one time.

Table (19): K% and uptake (mg /plant) of plant foliage of common bean as affected by time and frequency of superphosphate fertilization during 1998 & 1999.

Treatments Kg SP/fed.	K%		K-uptake (mg/plant)			K%		K-uptake (mg/plant)		
	Leaves	Stems	Leaves	Stems	Total	Leaves	Stems	Leaves	Stems	Total
	First season 1998					Second season 1999				
Control	2.32	2.460	229.50	123.25	352.750	2.280	2.260	224.50	119.75	334.250
200	2.55	2.505	255.00	125.37	380.370	2.500	2.305	250.00	121.87	371.870
50+150	2.67	2.720	267.75	136.00	403.750	2.580	2.520	262.75	132.25	395.000
100+100	2.93	2.975	293.25	148.75	442.000	2.820	2.775	288.00	142.25	430.250
100+25(S)+100+25(S)	2.93	3.225	293.25	161.50	454.750	2.910	3.250	290.62	158.00	448.800
50+100+50	2.06	3.525	306.00	171.87	477.870	2.980	3.325	300.00	168.37	468.370
L.S.D at 0.05	0.17	0.21	19.11	12.41	23.57	0.11	0.230	4.72	1.46	4.770

Moreover, adding elemental sulphur with SP i.e. 100 SP + 23 S at two times increased K-uptake. This trend was true and variances were significant in both seasons. This result could be referred to the improvement in growth of plants supplied with P at 3 or 2 application which improved K% and its uptake. These improvements in K uptake by splitting P fertilizer at 3 doses have been mentioned by *Abd El-All (1999)* on cauliflower.

4.2.4. Effect of time and frequency of P fertilizer on chemical constituents of dry seeds:

Data of the effect of time and frequency of P-fertilizer on N, P and K content of dry seeds are given in Table (20) show that adding super phosphate fertilizer at 3-split applications (50 + 100 + 50 kg SP / fed) resulted higher and significant N and K content as shown in both seasons, Whereas, P content was significant increase in one season only as compared with the other treatments, i.e. adding super phosphate at 2-split applications or when all P-fertilizer was added at one time or the control. This result reflect the high uptake of P by plants when P-fertilizer was added at several times, which led to more available phosphorus in soil for along time through the season and consequently more P-uptake. Moreover, adding P at one time depressed N-uptake due to the antigonism between NO_3 and HPO_4^{--} uptake under the high P-level in the soil at one time ***(Marchner, 1986)***. This result is in agreement with those obtained by ***Abd El-All (1999)*** on cauliflower

Table (20): N, P and K % and its uptake (g / plant) of common bean dry seeds as affected by time and frequency of super phosphate application during 1998 & 1999.

Treatments Kg SP / fed	Element %			Element uptake g / plant			Element %			Element uptake g / plant		
	N	P	K	N	P	K	N	P	K	N	P	K
	First season 1998						Second season 1999					
Cont.	2.610	0.432	1.185	1.696	0.215	1.05	2.560	0.523	1.866	1.355	0.271	1.260
200	2.760	0.450	1.270	1.823	0.231	1.09	2.640	0.570	1.910	1.485	0.308	1.350
50 + 150	2.760	0.464	1.315	1.883	0.247	1.135	2.860	0.574	1.950	1.593	0.318	1.404
100 + 100	2.870	0.472	1.385	1.917	0.250	1.205	2.900	0.583	1.955	1.644	0.327	1.426
100 + 25 (S) + 100 + 25 (S)	3.080	0.481	1.386	2.000	0.256	1.206	3.080	0.615	2.023	1.739	0.347	1.488
50 + 100 + 50	3.220	0.489	1.540	2.186	0.277	1.360	3.380	0.639	2.165	1.993	0.384	1.643
L.S.D. at 0.05	0.23	N.S.	0.150	0.080	N.S.	0.06	0.23	0.06	0.15	0.12	0.03	0.11

who reported that adding SP fertilizer at 3-split applications gave higher N, P and K content in dry seeds.

Table (C): Economical coasts of DAP fertilizer versus SP . (Average of two seasons)

P-source 32 kg P_2O_5 /fed.	Fertilizer Kg / fed.	Fertilizer coast L.E/fed.			Dry seed yield	
		N	P_2O_5	Total	kg / fed.	L.E/ fed.
DAP	78	207	97.5	304.5	952.38	3333.33
SP	200	300	200	500	747.62	2616.84
Differences	122	93	102.5	195.5	204.67	716.66

From the economical point of view it could be concluded from the previous Table, that plants supplied with 32 kg P_2O_5 /fed. as DAP required 78 kg of DAP + 134 kg ammonium sulphate coasted 304.5 L.E . This treatment produced 952.38 kg of dry seed yield /fed. as an average for the two seasons . Plants supplied with SP at the same level; 32 kg P_2O_5 / fed., coasted 200 L.E. this treatment produced 747.62 of dry seed yield /fed. as an average for the two seasons .

The balance of these two treatments showed that plants supplied with DAP gave higher dry seed yield with 204.76 kg /fed. it is price about 617.66 L.E

Its obvious that by using DAP we can save 195.5 L.E as for fertilizer coast, in the same time, using DAP resulted higher dry seed yield about 204.76 kg / fed. it is price about 716.66 L.E .

Generally, using 32 kg P_2O_5 / fed. as DAP saved 195.5 + 716.66 = 912.16 L.E /fed. as compared with using SP at the same level.