

## **Effect of Bio- and Mineral Phosphorus Fertilizer on the Growth, Productivity and Nutritional Value of Some Faba Bean (*Vicia faba* L.) Cultivars in Newly Cultivated Land**

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**Abstract:** Two field experiments were carried out to study the effect of bio-and mineral phosphorus fertilizer on the growth, productivity and nutritional value of some faba bean cultivars in newly cultivated land at New Salheyia region, Sharkia Governorate. The main results were: Giza-Blanka cultivar significantly outweighed Giza-483 cultivar in growth characters at 90 and 105 days (except SLW) and yield and its components except straw yield/plant and/or fed. and protein % per seeds. The application of bio-P fertilizer named phosphorene in two doses significantly increased growth parameters (except SLW) at 90 and 105 days age and yield and its components compared with one dose and control (without bio-P. fertilizer) treatments. The addition of mineral P. fertilizer at a rate of 46.5 kg P<sub>2</sub>O<sub>5</sub>/fed. resulted significant increment in growth characters of faba bean plants and yield and its components in comparison with 15.5 and 31.0 kg P<sub>2</sub>O<sub>5</sub>/fed treatments. With respect of the interaction between cultivars, bio-P fertilizer and mineral P. fertilizer, the interaction between cultivars × Bio-fertilizer was significant on growth characters (except on LAI at 90 days and on SLW at 90 and 105 days) and on yield and its components. In addition, the interaction between cultivars × P<sub>2</sub>O<sub>5</sub> rates was significant on growth parameters ( except leaves dry weight at 90 days ) and yield and its components, whereas, the effect of the interaction between phosphorene × P<sub>2</sub>O<sub>5</sub> was significant on growth characters (except number of branches at 105 days and on leaves dry weight/plant after 90 days from sowing) and on yield and its components. The three way interaction Cultivars × Phosphorene × P<sub>2</sub>O<sub>5</sub> was significantly affected growth characters (except leaves dry weight/plant, LAI and SLW at 90 and 105 days after sowing) and yield and its components. Generally, Giza-Blanka cultivars treated with two doses of Bio-P fertilizer and 46.5 kg P<sub>2</sub>O<sub>5</sub>/fed. produced the highest significant values from growth parameters (except SLW) and yield and its components (except number of branches per plant, straw yield per plant and per fed. and protein % per seeds).

### **Key words:**

### **INTRODUCTION**

Faba bean is one of the principal winter food legume crops in Egypt as a source of vegetable protein. Many efforts have been made to improve the productivity of faba bean<sup>[1-4]</sup>. The yield potential of faba bean can be defined as the total biomass produced or the agricultural important part of the crop. The total biomass is a result of the integration of metabolic reactions in the plant. Consequently, any factor influencing the metabolic activity of the plant at any period of its growth can affect the yield. Metabolic processes of faba bean plant are greatly governed by both internal, i.e. genetic make up of the plant and external conditions which involve two main factors namely climatic and edaphic environmental factors. The

yield potential of faba bean could be regulated through alternation of genetical make up and reconstitution of genetical structure through breeding programs and or by modification of environmental through cultural treatments. Thus the objective of this study is to investigate effect of bio- and mineral phosphorus fertilizer on the growth, productivity and nutritional value of some faba bean cultivars in newly cultivated land at New Salheyia Region, Sharkia Governorate.

### **MATERIALS AND METHODS**

Two field experiments were carried out in newly cultivated lands under sandy soil conditions at the New Salheyia Region, Sharkia Governorate, during the two successive seasons of 2004/2005 and 2005/2006 to

**Table 1:** Mechanical and chemical analysis of soil at experimental sites (Average of 2004 and 2005 seasons).

Sand %	Silt %	Clay %	Texture	pH	Organic matter %	Available N. (p.p.m.)	Available P. (p.p.m.)	Available K. (p.p.m.)
73.2	23.2	3.6	Sandy	8.0	0.50	43	12.5	135

study effect of bio- and mineral phosphorus fertilizer on the growth, productivity and nutritional value of some faba bean cultivars (*Vicia faba* L.). Each experiment included eighteen treatments which were the combination of two faba bean cultivars, i.e. Giza-Blanka and Giza-483 and nine treatments representing the interaction between three application doses of the bio-fertilizer (phosphorene), i.e. without, one dose or two doses with three rates of mineral phosphorus, i.e. 15.5, 31 and 46.5 kg P<sub>2</sub>O<sub>5</sub>/fed. as superphosphate 15.5 % P<sub>2</sub>O<sub>5</sub>. The treatments were arranged in a split-split block design with three replicates, where faba bean cultivars were distributed in the main plots, meanwhile, phosphorene treatments were occupied to the sub-plots and mineral phosphorus treatments were distributed in sub-sub plots. The experimental unit consisted seven ridges five meter in length and 60 cm apart. Seeds of faba bean were obtained from Agriculture Research Centre, Ministry of Agriculture and were planted on November 16<sup>th</sup> and 20<sup>th</sup> in 2004 and 2005, respectively, 10 cm between hills at a seeding rate of 80 kg/fed. Soil characteristics are presented in Table (1).

Normal cultural practices were followed as usual in faba bean fields. After complete germination and at 20 days after sowing plants were thinned leaving one plant per hill. Phosphorene was applied as recommended by Ministry of Agriculture (two packages each of 1 kg/fed) once at sowing or twice, i.e. at sowing and one month later, as compared to the control (without).

Plant height (cm), number of branches, leaves and pods/plant, dry weight of branches, leaves, pods/plant in "gm" were estimated at 90 and 105 days from sowing by harvesting five guarded plants at random from each treatment. Also, area of leaves (LA) "cm<sup>2</sup>/plant" was computed as Bremner and Taha<sup>[5]</sup>, leaf area index (LAI) was determined according to Watson<sup>[6]</sup> and specific leaf weight (SLW) was calculated as Pearce *et al.*<sup>[7]</sup>. Random often green pods of each treatment was taken at 105 days after sowing for the chemical analysis purpose, i.e. N, P, K, protein, total soluble sugars and ascorbic acid (vitamin C) determination. N, P and K were determined according to Black<sup>[8]</sup>, Watanab and Olsen<sup>[9]</sup> and Jakosn<sup>[10]</sup>, respectively. The percentage of crude protein, total soluble sugars and ascorbic acid (vitamin C) were determined according to A.O.A.C.<sup>[11]</sup>

At full maturity, plant height, number of branches, pods and seeds/plant, weight of pods/plant in "gm" and seed and straw yields/plant were recorded using a sample of ten random guarded plants from the middle

ridges of each plot, meanwhile, seeds, straw and biological yields(ton/fed) were determined from the three middle rows of every plot. To calculate protein yield "kg/fed"; total nitrogen (%) was determined according the method described by A.O.A.C.<sup>[11]</sup> and was multiplied by 5.75 % to calculate protein (%).

Statistical analysis was performed according to Snedecor and Cochran<sup>[12]</sup>. Combined analysis was made for the two growing seasons hence the results of two seasons followed similar trend. For comparison between means, LSD test at 5% level was used.

## RESULTS AND DISCUSSIONS

### A- Growth Characters:

**A-1. Varietal Differences:** Data presented in Table (2) show that there were significant differences between faba bean cultivars in plant height, number and dry weight of branches, leaves and pods/plant, LA, LAI and SLW after 90 and 105 days from planting date. Moreover, it is clear that Giza-Blanka cultivar exceeded significantly Giza-483 cultivar in all previous growth characters except SLW. It is worthy to mention that plant height, number and dry weight of pods/plant, branches dry weight/plant tended to increase with advance in age until 105 days after sowing, meanwhile, number of branches/plant, number and dry weight of leaves/plant, LA, LAI and SLW tended to decrease after 90 days from sowing.

The differences among faba bean cultivars in growth characters may be due to the differences in number of nodules formed on the root of the tested cultivar, consequently, the growth of each cultivar may depended mainly on nitrogen fixation<sup>[13]</sup>, also to the differences in partition and migration of photosynthate between cultivars<sup>[1]</sup> and the endogenous hormones content<sup>[14]</sup>.

It could be mentioned that the results of the cultivar differences in growth characters, herein, are confirmed with those obtained by Hassanein<sup>[15]</sup>, Ahmed *et al.*<sup>[1]</sup>, Shalaby<sup>[3]</sup> and Shalaby and EL-Ashry<sup>[14]</sup>.

**A-2. Effect of Bio-P-Fertilizer:** Table (2) observed that application of phosphorene improved plant growth expressed as plant height, number and dry weight of branches, leaves and pods/plant, as well as, LA/plant at 90 and 105 days and LAI at 105 days significantly affected by bio-fertilizer treatment, meanwhile, the effect on LAI at 90 days and SLW at 90 and 105 days after sowing failed to reach the significant level at 5%.

**Table 2:** Effect of cultivars and/or bio and mineral phosphate fertilizer on growth characters of faba bean plants at 90 and 105 days after sowing. (Average of 2004/2005 and 2005/2006 seasons).

		Growth characters									
		Plant height "cm"		No. of branches/plant		No. of leaves/plant		No. of pods/plant		Branches dry weight "g/plant"	
Treatments	Plant age	90	105	90	105	90	105	90	105	90	105
Cultivars 1	Giza-Blanka	105.14	126.37	6.25	5.54	48.36	45.03	27.47	39.34	9.78	11.55
	Giza-843	99.87	123.90	5.13	4.56	43.18	38.99	25.17	33.25	9.03	10.91
L.S.D.at5%level		2.37	1.55	0.12	0.50	2.77	3.41	1.08	2.85	0.07	0.11
Phosphorene	Without	88.38	116.85	4.10	3.78	43.00	39.19	21.77	31.08	7.01	9.52
	One dose	100.03	127.43	5.85	5.22	45.93	41.41	26.19	35.35	9.80	11.33
	Two doses	119.13	139.64	7.12	6.16	48.38	45.44	31.01	42.47	11.41	12.85
L.S.D. at 5 % level		1.12	1.28	0.36	0.73	1.71	1.90	1.07	1.73	0.27	0.34
P205 rates	15.5 "kg/fed"	93.23	119.19	4.90	4.14	42.75	38.31	20.96	27.32	8.16	10.18
	31.0 "kg/fed"	104.20	129.55	5.87	5.08	46.58	42.72	25.05	38.12	9.42	11.25
	46.5 "kg/fed"	110.13	135.19	6.30	5.64	48.00	45.01	32.79	43.45	10.64	12.38
L.S.D. at 5 % level		1.95	2.77	0.43	0.41	2.07	1.33	0.90	1.09	0.80	1.00

  

		Growth characters									
		Leaves dry weight "g/plant"		Pods dry weight "g/plant"		Leaves area (LA)"cm <sup>2</sup> /plant"		Leaf area index (LAI)		Specific leaf weight (SLW) "mg/cm <sup>2</sup> "	
Treatment	Plant age	90	105	90	105	90	105	90	105	90	105
Cultivars 1	Giza-Blanka	8.24	7.56	38.02	50.59	1711.33	1623.89	2.85	2.71	4.18	4.66
	Giza-843	7.85	7.17	28.74	41.14	1581.89	1501.11	2.64	2.50	4.95	4.78
L.S.D.at5%level		0.16	0.05	2.61	1.33	21.34	16.40	0.12	0.11	0.03	0.09
Phosphorene	Without	7.51	6.87	13.41	34.68	1553.67	1480.34	2.59	2.46	4.84	4.66
	One dose	8.02	7.33	34.74	47.80	1658.34	1572.50	2.77	2.62	4.83	4.67
	Two doses	8.63	7.99	41.44	55.07	1727.84	1639.67	4.83	2.74	4.99	4.82
L.S.D. at 5 % level		0.41	0.23	1.66	1.19	5.32	6.18	n.s	0.15	n.s	n.s
P205 rates	15.5 "kg/fed"	7.86	7.04	26.56	41.08	1559.83	1465.50	2.61	2.44	5.04	4.88
	31.0 "kg/fed"	8.04	7.35	34.41	45.88	1661.67	1580.34	2.77	2.64	4.82	4.66
	46.5 "kg/fed"	8.24	7.71	39.24	50.60	1718.50	1641.33	2.87	2.74	4.80	4.70
L.S.D. at 5 % level		0.15	0.07	0.09	1.09	4.74	5.13	0.11	0.08	0.05	0.06

Data also indicated that two doses application of phosphorene showed an increment in plant growth that of one dose application treatment. The increment in growth characters were significant compared with one dose and control treatment (without bio-fertilizer), except the differences between one dose and two doses in (LAI and SLW) were not significant.

It could be concluded that application of the bio-P-fertilizer named phosphorene increased plant growth and dry matter due to that phosphorene enhanced phosphorous solubilization [16]. The effect of bio-fertilizer may be due to the effect of nutrients mobilizing microorganisms which help in availability of metals and increased levels of extractable mineral [17]. The obtained results agreed with

those of Sherif *et al.*, [18] who; mentioned that phosphates dissolving bacteria presses the ability to bring a soluble phosphate in soluble forms secreting organic acids which lower the pH and bring about the dissolution of bonds forms of phosphate and render then available for growing plants.

The results of bio-P- fertilizer in growth parameters obtained in this study are in agreement with those obtained by EL-Sawah *et al.* [19], Ashour [20], Mansour [21], El-Kalla *et al.* [22], Abdalla *et al.* [23], Abdel - Mouty *et al.* [24], Abdalla [4] and Ahmed *et al.* [25].

**A-3 Effect of Mineral P. Fertilizer:** The addition of mineral phosphorous fertilizer at rate 46.5 Kg/fed. P<sub>2</sub>O<sub>5</sub> resulted in a significant increase in growth characters

**Table 3:** Effect of interaction between cultivars x P<sub>2</sub>O<sub>5</sub> and phosphorene x P<sub>2</sub>O<sub>5</sub> on growth characters of faba bean plants at 90 and 105 days after sowing. (Average of 2004/2005 and 2005/2006 seasons).

		Growth characters									
Interaction	Plant age	Plant height "cm"		No. of branches/plant		No. of leaves/plant		No. of pods/plant		Branches dry weight "g/plant"	
		90	105	90	105	90	105	90	105	90	105
<b>Cultivars x phosphorene int.:-</b>											
Giza-Blanka	Without	90.33	120.57	4.46	4.22	45.83	42.41	22.90	32.57	7.22	9.72
	One dose	102.53	132.16	6.49	5.66	48.23	44.19	27.20	38.56	10.05	11.57
	Two doses	122.55	143.42	7.80	6.75	51.03	48.49	32.31	46.90	12.07	13.36
Giza-843	Without	86.37	113.13	3.73	3.33	40.17	35.97	20.63	29.58	6.80	9.32
	One dose	97.53	122.70	5.22	4.78	43.63	38.62	25.17	32.14	9.54	11.08
	Two doses	115.70	135.86	6.43	5.56	45.73	42.38	29.70	38.03	10.74	12.34
L.S.D. at 5 % level		1.58	1.80	0.50	1.03	2.68	2.68	1.51	2.45	0.38	0.48
<b>Cultivars x P<sub>2</sub>O<sub>5</sub> kg/fedInt :-</b>											
Giza-Blanka	15.5	95.63	122.71	5.45	4.99	45.80	42.68	21.88	28.62	8.60	10.47
	31.0	106.89	133.59	6.47	5.49	48.97	45.11	26.17	41.60	9.77	11.48
	46.5	122.99	139.85	6.83	6.16	50.33	47.31	34.37	47.80	10.97	12.90
Giza-843	15.5	90.83	115.66	4.35	3.89	39.69	33.93	20.30	26.02	7.71	9.89
	31.0	101.50	125.50	5.27	4.67	44.18	40.33	24.00	34.63	9.07	11.01
	46.5	107.27	130.53	5.77	5.11	45.67	42.70	31.20	39.10	10.30	11.85
L.S.D. at 5% level		2.76	3.93	0.61	0.58	2.92	1.89	1.27	1.54	1.14	1.41
<b>Phosphorene x P<sub>2</sub>O<sub>5</sub> kg/fed Int.:-</b>											
Without	15.5	81.30	109.20	3.34	3.09	45.80	35.49	15.75	23.52	6.25	8.88
	31.0	88.75	116.25	4.30	3.92	43.53	39.34	21.30	31.65	6.98	9.30
	46.5	95.00	125.00	4.15	4.34	45.50	42.75	28.25	38.05	7.79	10.40
One dose	15.5	87.80	116.57	4.88	4.44	43.05	37.20	20.75	26.50	8.25	10.05
	31.0	101.80	131.60	6.10	5.15	46.75	42.34	24.70	36.30	9.73	11.27
	46.5	110.65	134.13	6.59	6.07	48.00	44.69	33.10	43.25	11.41	11.41
Two doses	15.5	110.60	131.79	6.49	5.80	45.20	42.24	26.77	31.95	9.97	11.62
	31.0	122.04	140.79	7.20	6.17	49.45	46.50	29.25	46.40	11.55	13.18
	46.5	124.74	146.35	7.67	6.50	50.50	47.57	37.00	49.05	12.70	13.76
L.S.D. at 5% level		3.39	4.80	0.75	n.s	3.58	2.32	2.03	1.89	1.39	1.73
		Growth characters									
Interaction	Plant age	Leaves dry weight "g/plant"		Pods dry weight "g/plant"		Leaves area (LA) "cm <sup>2</sup> /plant"		Leaf area index (LAI)		Specific leaf weight (SLW) "mg/cm <sup>2</sup> "	
		90	105	90	105	90	105	90	105	90	105
<b>Cultivars x phosphorene int.:-</b>											
Giza-Blanka	Without	7.66	7.04	26.82	36.85	1626.00	1547.00	2.71	2.58	4.71	4.55
	One dose	8.12	7.49	39.14	54.20	1720.00	1621.00	2.87	2.70	4.73	4.63
	Two doses	8.95	8.16	48.09	60.62	1788.00	1703.67	2.98	2.84	5.00	4.79

**Table 3:** Continue

Giza-843	Without	7.35	6.70	21.10	32.50	1481.33	1403.67	2.47	2.34	4.96	4.77
	One dose	7.91	7.16	30.34	41.40	1596.67	1524.00	2.66	2.54	4.92	4.70
	Two doses	8.30	7.64	34.79	49.51	1667.67	1575.67	2.78	2.63	4.98	4.86
L.S.D. at 5 % level		0-58	0-32	2.35	1.67	7.52	8.75	n.s	0.21	n.s	n.s
Cultivars x P <sub>2</sub> O <sub>5</sub> kg/fed Int :-											
Giza-Blanka	15.5	7.93	7.20	31.09	45.00	1623.33	1528.00	2.71	2.55	4.88	4.71
	31.0	8.27	7.56	39.18	50.58	1723.00	1634.67	2.87	2.72	4.80	4.62
	46.5	8.53	7.94	43.79	56.13	1788.00	1709.33	2.98	2.85	4.77	4.64
Giza-843	15.5	7.79	6.88	21.90	37.16	1496.33	1403.00	2.50	2.33	5.20	5.05
	31.0	7.81	7.14	29.63	41.18	1600.33	1526.00	2.67	2.55	4.84	4.69
	46.5	7.95	7.48	34.69	45.06	1649.00	1573.33	2.75	2.63	4.83	4.75
L.S.D. at 5% level		n.s	0.10	1.27	1.54	6.71	7.25	0.15	0.12	0.07	0.08
Phosphorene x P <sub>2</sub> O <sub>5</sub> kg/fed Int.:-											
Without	15.5	7.21	6.41	19.04	30.37	1475.00	1391.00	2.46	2.32	4.89	4.16
	31.0	7.53	6.91	24.72	35.64	1564.00	1478.00	2.61	2.47	4.83	4.66
	46.5	7.78	7.31	28.13	38.01	1622.00	1557.50	2.71	2.60	4.80	4.70
One dose	15.5	7.85	7.07	26.28	43.28	1552.50	1457.50	2.59	2.43	5.07	4.58
	31.0	8.00	7.20	35.91	46.38	1685.00	1602.50	2.81	2.67	4.69	4.49
	46.5	8.20	7.72	42.05	53.74	1738.00	1657.50	2.90	2.77	2.72	4.66
Two doses	15.5	8.53	7.66	34.70	49.61	1652.00	1548.00	2.76	2.56	5.16	4.95
	31.0	8.59	7.95	42.60	55.54	1736.00	1660.50	2.90	2.77	4.95	4.79
	46.5	8.76	8.10	47.57	60.04	1795.50	1710.50	3.00	2.85	4.88	4.74
L.S.D. at 5% level		n.s	0.12	1.55	1.89	8.21	8.88	0.19	0.14	0.08	0.11

of faba bean plants compared with 15.5 and 31 Kg P<sub>2</sub>O<sub>5</sub>/fed. rates, except, the increase from 31.0 to 46.5 Kg P<sub>2</sub>O<sub>5</sub>/fed. showed no significant increase in (number of leaves/plant and LAI at 90 days and SLW at 90 and 105 days after sowing) (Table 2).

The positive effect of phosphorus fertilizer on growth characters, here, may be due to the physiological role of P on the meristematic activity of plant tissues and consequently increasing plant growth, also, its function as a part of enzyme system having a vital role the synthesis of other foods from carbohydrate.

It could be concluded that our results are in harmony with those obtained by Hassanein<sup>[15]</sup>, Adam<sup>[26]</sup>, Abdalla<sup>[4]</sup> and Ahmed *et al.*<sup>[24]</sup>.

**A-4. Effect of the Interactions:** Table (3) indicate that the interaction between cultivars × bio-fertilizer significantly affected growth character, i.e. plant height, number and dry weigh of branches, leaves and pods/plant, LA at 90 and 105 days and LAI at

105 days, whereas, the response of LAI at 90 days and SLW at 90 and 105 days due to the interaction were not significant. Generally, it could be concluded that the highest values of the previous growth parameters were recorded by Giza-Blanka cultivar treated with Bio-P. fertilizer at two doses and this was true at 90 and 105 days, except, SLW at 105 days where Giza-483 cultivars gave the highest value under two doses of bio-P. fertilizer.

Regarding the interaction between cultivars × mineral fertilizers the effect on all growth parameters during the different two stages of growth was significant except leaves dry weight/plant at 90 days after sowing, also, Giza-Blanka cultivars had the highest significant values of growth characters under 46.5 Kg P<sub>2</sub>O<sub>5</sub>/fed treatments meanwhile, Giza-483 with 15.5 kg P<sub>2</sub>O<sub>5</sub>/fed produced the greatest SLW value at 90 and 105 days after sowing (Table 3).

With respect of bio-P and mineral P. fertilizer interaction, it could be noticed that the effect of interaction on growth characters was significant at

**Table 4:** Effect of the three-way interaction between faba bean cultivars xphosphorene x P<sub>2</sub>O<sub>5</sub> levels on growth characters of faba bean plants at 90 and 105 days after sowing (Average of 2004/2005 and 2005/2006 seasons)

Var.	Phosphorene	P <sub>2</sub> O <sub>5</sub> "kg/fed"	Growth characters										
			Plant height "cm"		No. of branches/plant		No. of leaves/plant		No. of pods/plant		Branches dry weight "g/plant"		
			90	105	90	105	90	105	90	105	90	105	
Giza-Blanka	Without	15.5	83.00	113.90	3.67	3.50	43.30	40.17	16.70	24.70	6.49	9.02	
		31.0	91.00	118.60	4.70	4.50	46.20	41.67	22.60	32.80	7.18	9.51	
		46.5	97.00	129.20	5.00	4.67	48.00	45.40	29.40	40.20	7.98	10.63	
	One dose	15.5	90.60	119.33	5.50	4.87	45.80	42.20	21.60	27.67	8.42	10.08	
		31.0	104.00	137.50	6.80	5.30	48.90	43.67	25.40	40.10	9.98	11.44	
		46.5	113.30	139.66	7.17	6.80	50.00	46.70	34.60	47.90	11.74	13.18	
	Two doses	15.5	113.30	134.90	7.17	6.60	48.30	45.67	27.33	33.50	10.89	12.32	
		31.0	125.67	144.67	7.90	6.67	51.80	50.00	30.50	51.90	12.14	13.50	
		46.5	128.67	150.70	8.33	7.00	53.00	49.80	39.10	55.30	13.18	14.27	
	Giza-843	Without	15.5	79.60	104.50	3.00	2.67	36.67	30.80	14.80	22.33	6.01	8.73
			31.0	86.50	113.90	3.90	3.33	40.85	37.00	20.00	30.50	6.78	9.08
			46.5	93.00	121.00	4.30	4.00	43.00	40.10	27.10	35.90	7.60	10.16
One dose		15.5	85.00	113.80	4.25	4.00	40.30	32.20	19.90	25.33	8.08	10.01	
		31.0	99.60	125.70	5.40	5.00	44.60	41.00	24.00	32.50	9.47	11.09	
		46.5	108.00	128.60	6.00	5.33	46.00	42.67	31.60	38.60	11.08	12.15	
Two doses		15.5	107.90	128.67	5.80	5.00	42.10	38.80	26.20	30.40	9.04	10.92	
		31.0	118.40	136.90	6.50	5.67	47.10	43.00	28.00	40.90	10.95	12.86	
		46.5	120.80	142.00	7.00	6.00	48.00	45.33	34.90	42.80	12.22	13.24	
L.S.D. at 5 % level			4.79	6.81	1.06	1.08	6.35	3.28	2.21	2.67	1.97	2.45	

Var.	Phosphorene	P <sub>2</sub> O <sub>5</sub> "kg/fed"	Growth characters									
			Leaves dry weight "g/plant"		Pods dry weight "g/plant"		Leaves area (LA) "cm <sup>2</sup> /plant"		Leaf area index ( LAI )		Specific leaf weight (SLW) "mg/cm <sup>2</sup> "	
			90	105	90	105	90	105	90	105	90	105
Giza-Blanka	Without	15.5	7.31	6.52	21.31	31.17	1525	1441	2.54	2.40	4.79	4.52
		31.0	7.65	7.04	27.55	38.85	1639	1548	2.73	2.58	4.67	4.55
		46.5	8.01	7.58	31.60	40.52	1714	1653	2.86	2.76	4.67	4.58
	One dose	15.5	7.90	7.18	30.72	48.66	1632	1513	2.72	2.52	4.84	4.75
		31.0	8.12	7.37	40.52	52.38	1748	1646	2.91	2.74	4.65	4.48
		46.5	8.35	7.92	46.19	61.56	1781	1704	2.97	2.84	4.69	4.65

**Table 4:** Continue

	Two doses	15.5	8.57	7.91	41.23	55.18	1713	1630	2.86	2.72	5.00	4.85
		31.0	9.03	8.27	49.47	60.35	1782	1710	2.97	2.85	5.07	4.84
		46.5	9.24	8.31	53.58	66.32	1869	1771	3.12	2.95	4.95	4.69
Giza-843	Without	15.5	7.10	6.29	16.76	29.56	1425	1341	2.38	2.24	4.98	4.69
		31.0	7.41	6.78	21.88	32.43	1489	1408	2.48	2.35	4.98	4.82
		46.5	7.55	7.03	24.66	35.50	1530	1462	2.55	2.44	4.93	4.81
	One dose	15.5	7.80	6.95	21.83	37.96	1473	1402	2.46	2.34	5.30	4.95
		31.0	7.88	7.02	31.30	40.37	1622	1559	2.70	2.60	4.73	4.50
		46.5	8.04	7.51	37.90	45.92	1695	1611	2.83	2.69	4.74	4.66
	Two doses	15.5	8.48	7.40	27.10	44.03	1591	1466	2.65	2.44	5.32	5.05
		31.0	8.15	7.63	35.72	50.73	1690	1611	2.82	2.69	4.82	4.74
		46.5	8.27	7.89	41.55	53.76	1722	1650	2.87	2.75	4.81	4.78
L.S.D. at 5 % level			n.s	n.s	2.19	2.67	11.61	12.56	n.s	n.s	n.s	n.s

**Table 5:** Effect of cultivars and/or bio- and mineral phosphate fertilizer on the chemical composition of faba bean green pods. (Average of 2004/2005 and 2005/2006 seasons)

Treatments		N%	Protein %	P%	K%	Total Soluble sugars %	V.C. (mg/10g.fresh wt.)
Cultivars	Giza-Blanka	4.03	4.29	0.39	2.17	6.38	14.27
	Giza-843	4.89	4.48	0.36	2.31	6.16	13.51
L.S.D. at 5% level		0.04	0.05	0.02	0.09	0.11	0.08
Phosphorene	Without	3.64	3.87	0.35	2.13	6.14	12.98
	One dose	4.1	4.49	0.38	2.27	6.29	13.74
	Two doses	4.43	4.79	0.41	2.32	6.4	14.96
L.S.D. at 5% level		0.07	0.09	n.s	n.s	0.08	0.02
P <sub>2</sub> O <sub>5</sub> "kg/fed"	15.5	3.77	4.01	0.34	2.17	6.11	12.92
	31	3.96	4.31	0.38	2.24	6.28	14.17
	46.5	4.44	4.84	0.42	2.31	6.43	14.58
L.S.D. at 5% level		0.07	0.1	0.04	0.05	0.09	0.03

90 and 105 days, except number of branches/plant at 105 days and leaves dry weight/plant at 90 days. Generally, it could be concluded that the highest significant values of growth characters were resulted by plants treated with bio-P. fertilizer at two doses and supplied with 46.5 Kg P<sub>2</sub>O<sub>5</sub>/fed. On the contrary, the greatest significant value from SLW was collected from faba bean plants treated with Bio-P. fertilizer at two doses and supplied with the minimum rate of chemical P, Table (3).

It is note worthy to mention, that the three-way interaction between cultivar × bio-P. fertilizer × mineral-P. fertilizer significantly affected plant height, number and dry weigh of branches and pods/plant, number of leaves/plant as well as LA per plant were

significant, however, the effect on leaves dry weight/plant, LAI and SLW failed to reach significant level at 5%. It could be summarized the results of the three way interaction as the most favourable treatments to produce the highest values from the studied growth parameters was Giza-Blanka cultivar treated with Bio-P. fertilizer at two doses and supplied with maximum rate of P<sub>2</sub>O<sub>5</sub> fertilizer (Table 4).

**B- Nutritional Values of Green Pods:** Data in Table (5) indicated that the nutritional value of green pods of faba bean is significantly affect by differences since Giza-Blanka significantly exceeded Giza-483 cultivar in P%, total soluble sugars % and V.C., meanwhile, Giza-483 plants recorded the height

**Table 6:** Effect of interaction between cultivars x phosphorene, cultivars x P<sub>2</sub>O<sub>5</sub> and phosphorene x P<sub>2</sub>O<sub>5</sub> on the chemical composition of faba bean green pods at 105 days. (Average of 2004/2005 and 2005/2006 seasons)

Interaction			N%	Protein%	P%	K%	Total Soluble sugars %	V.C. (mg/10g.fresh wt.)	
Cultivars × Phosphorene Interaction	Giza-Blanka	Without	3.60	3.74	0.36	2.04	6.25	13.46	
		One dose	4.08	4.43	0.39	2.20	6.38	14.02	
		Two doses	4.40	4.70	0.42	2.26	6.51	15.34	
	Giza-483	Without	3.68	4.00	0.34	2.21	6.02	12.51	
		One dose	4.12	4.55	0.36	2.34	6.19	13.46	
		Two doses	4.46	4.88	0.39	2.37	6.28	14.57	
L.S.D. at 5% level			0.09	0.13	n.s	n.s	n.s	0.03	
Cultivars × P <sub>2</sub> O <sub>5</sub> Interaction	Giza-Blanka	15.5 kg/fed	3.72	3.87	0.35	2.09	6.23	13.26	
		31.0 kg/fed	3.94	4.22	0.39	2.17	6.34	14.55	
		46.5 kg/fed	4.43	4.78	0.44	2.25	6.57	15.01	
	Giza-483	15.5 kg/fed	3.81	4.14	0.33	2.24	5.99	12.58	
		31.0 kg/fed	3.98	4.39	0.36	2.31	6.21	13.78	
		46.5 kg/fed	4.45	4.90	0.40	2.36	6.28	14.17	
	L.S.D. at 5% level			0.10	0.14	n.s	n.s	n.s	0.04
	Phosphorene × P <sub>2</sub> O <sub>5</sub> Interaction	Without	15.5 kg/fed	3.43	3.58	0.32	2.05	5.97	12.04
			31.0 kg/fed	3.63	3.72	0.35	2.15	6.15	13.19
46.5 kg/fed			3.87	4.33	0.39	2.19	6.29	13.73	
One dose		15.5 kg/fed	3.83	4.04	0.34	2.21	6.15	12.79	
		31.0 kg/fed	3.98	4.50	0.37	2.28	6.29	13.96	
		46.5 kg/fed	4.51	4.93	0.43	2.34	6.43	14.48	
Two doses		15.5 kg/fed	4.04	4.41	0.38	2.25	6.23	13.94	
		31.0 kg/fed	4.27	4.17	0.40	2.30	6.38	15.36	
		46.5 kg/fed	4.95	5.26	0.46	2.39	6.58	15.58	
L.S.D. at 5% level			0.12	0.17	n.s	n.s	n.s	0.05	

significant values from N%, protein% and K%. Again, data in the same table observed that two doses application from phosphorene produced faba bean green pods characterized by the highest content from the chemical constituents studied compared with without application (control) and one dose of phosphorene treatments. With respect of the mineral phosphorus rate, data illustrated in Table (5), show clearly that supplied faba bean plants with 46.50 Kg P<sub>2</sub>O<sub>5</sub>/fed gave the greatest mean values from, N%, protein%, P%, K%, total soluble sugars% and V.C. compared with 15.5 and 31.0 Kg P<sub>2</sub>O<sub>5</sub>/fed treatments.

With respect to the interaction between cultivar × P<sub>2</sub>O<sub>5</sub> and phosphorene × P<sub>2</sub>O<sub>5</sub>, Table (6) show that the effects on N%, protein% and V.C. were significant, meanwhile, the effects on P%, K% and total soluble sugars were not significant.

Generally, Giza-Blanka cultivar treated with two

doses from phosphorene, also, Giza-Blanka with 46.5 Kg P<sub>2</sub>O<sub>5</sub> /fed. gave faba bean plants characterized by green pods high in its content from P%, total soluble sugars and V.C., whereas, the green pods of faba bean with high content from N%, protein% and K% collected from Giza-483 plants under two doses application from phosphorene and Giza-483 plants with 46.5 Kg P<sub>2</sub>O<sub>5</sub>/fed.

With respect of the three –way interaction cultivar × Biofertilizer × Mineral fertilizer, data detected in Table (8) indicate clearly that the effect was significant on N%, protein % and V.C. ( except on P%, K% and total soluble sugars %.

Generally, Giza-Blanka cultivar recorded the highest N%, protein % and V.C. values in the green

**Table 7:** Effect of cultivars and/or bio- and mineral phosphate fertilizer on the yield and its components of faba bean plants.

		Yield components											
Treatments		Plant height "cm"	No. of branches/plant	No. of pods/plant	Weight of pods" g"	No. of seeds/plant	Seed yield g/plant	Straw yield g/plant	Seed yield ton/fed	Straw yield ton/fed	Biological yield ton/fed	Protein% per seeds	Protein yield ton/fed
Cultivars	Giza-Blanka	124.30	3.67	50.94	64.93	86.29	53.87	57.42	1.46	1.57	3.03	18.92	0.277
	Giza-843	113.34	3.95	43.88	55.39	79.76	48.04	60.06	1.28	1.63	2.91	20.44	0.262
L.S.D. at 5% level		3.64	0.11	2.42	3.22	3.40	2.27	1.14	0.06	0.04	0.02	0.13	0.008
Phosphorene	Without	107.53	3.65	39.66	49.50	75.36	44.72	51.22	1.22	1.46	2.68	18.59	0.228
	One dose	118.50	3.82	46.63	61.50	83.71	50.98	57.91	1.40	1.60	3.00	19.64	0.276
	Two doses	130.44	3.96	55.95	69.50	90.01	57.19	67.10	1.50	1.73	3.24	20.82	0.312
L.S.D. at 5% level		2.38	0.13	1.14	1.17	1.40	1.25	1.19	0.05	0.06	0.07	0.25	0.043
P <sub>2</sub> O <sub>5</sub> rates	15.5 "kg/fed"	110.04	3.65	41.20	52.41	71.14	43.22	50.75	1.25	1.50	2.75	18.59	0.232
	31.0 "kg/fed"	119.88	3.79	47.90	60.85	83.96	52.64	60.89	1.40	1.66	3.06	19.64	0.276
	46.5 "kg/fed"	126.56	3.98	52.72	67.32	93.99	57.00	64.58	1.48	1.69	3.17	20.82	0.307
L.S.D. at 5% level		3.12	0.11	1.22	1.28	1.38	1.29	1.23	0.06	0.06	0.07	0.28	0.045

Pods of faba bean at 105 days after sowing under two doses of phosphorene and 46.5 P<sub>2</sub>O<sub>5</sub> /fed.

**C- Yield and its Components:**

**C-1. Varietal Differences:** Data reported in Table (7) observed that faba bean cultivars significantly differed in plant height, number of branches, pods and seeds/plant, weight of pods/plant, seed and straw yield per plant and/or per fed, biological yield/fed, protein% per seeds as well as protein yield/fed. Furthermore, data show clearly that Giza-Blanka cultivar significantly surpassed Giza-483 cultivar in plant height, number of pods/plant, weight of pods/plant, number of seeds/plant, seed yield per plant and/or per fed, biological yield/fed and protein yield/fed, meanwhile, Giza-483 cultivar significantly exceeded Giza-Blanka in number of branches/plant, straw yield per plant and/or per fed. and protein% per seeds.

The differences between faba bean cultivars in the production efficiency may be due to the differences in number of nodules formed on the root of the tested cultivar, consequently, the growth of each cultivar may depend mainly on nitrogen fixation<sup>[13]</sup>, also, to the differences in partitioning and migration of photosynthate between faba bean cultivars<sup>[1]</sup> and in the content of endogenous hormones<sup>[14]</sup>.

Our results are in full agreement with those obtained Hassanein<sup>[15]</sup>, Ahmed *et al.*<sup>[1]</sup>, Shalaby<sup>[3]</sup> and shalaby and EL-Ashry<sup>[14]</sup>.

**C-2. Effect of bio-P. fertilizer:** Table (7) observed that application of phosphorene significantly improved plant height, number of branches, pods and

seeds/plant, weight of pods/plant, seed and straw yields per plant and/or per fed., protein% per seeds, as well as, biological and protein yields per fed by application phosphorene in two doses compared with one dose application and the control treatment (without phosphorene), except the differences between one dose and two doses of phosphorene in protein yield failed to reach the significant level at 5%. It could be concluded that application of the bio-P. fertilizer named phosphorene increased yield and its components and dry matter due to that phosphorene enhanced phosphorus solubilization<sup>[16]</sup>. The effect of bio-fertilizer may be due to the effect of nutrients mobilizing microorganism which help in availability of metal and increased levels of extractable minerals<sup>[17]</sup>. The obtained results are in harmony with those of<sup>[18]</sup>, who indicated that phosphate dissolving bacteria presses the ability to bring a soluble phosphate in soluble forms secreting organic acids which lower the pH and bring about the dissolution of bonds forms of phosphate and render then available for growing plants.

The results of bio-P-fertilizer in yield and its components obtained in this study are in agreement with those obtained by EL-Sawah *et al.*<sup>[19]</sup>, Ashour<sup>[20]</sup>, Mansour<sup>[21]</sup>, Abdalla *et al.*<sup>[25]</sup>, Abdel-Mouty *et al.*<sup>[24]</sup>, Abdalla<sup>[4]</sup> and Ahmed *et al.*<sup>[25]</sup>.

**C-3. Effect of mineral P. fertilizer:** The addition of mineral P. fertilizer at a rate of 46.5 Kg P<sub>2</sub>O<sub>5</sub>/fed. significantly increased all yield and its components studied in this study in comparison with the other two treatments 15.5 and 31.0 Kg P<sub>2</sub>O<sub>5</sub>/fed., except the differences between 31.0 and 46.5 Kg P<sub>2</sub>O<sub>5</sub>/fed.

**Table 8:** Effect of three-way interaction between cultivars x phosphorene, cultivars on the chemical composition of faba bean green pods at 105 days after sowing (Average of 2004/2005 and 2005/2006 seasons).

Interaction									
Cultivars	Phosphorene	P <sub>2</sub> O <sub>5</sub> (kg/fed)	N%	Protein %	P%	K%	Total Soluble sugars %	V.C. (mg/10g.fresh wt.)	
Giza-Blanka	Without	15.5	3.35	3.42	0.32	1.95	6.13	12.34	
		31.0	3.6	3.58	0.36	2.06	6.19	13.72	
		46.5	3.86	4.23	0.41	2.11	6.42	14.31	
	One dose	15.5	3.8	3.97	0.34	2.13	6.24	13.17	
		31.0	3.96	4.42	0.39	2.2	6.35	14.22	
		46.5	4.49	4.9	0.45	2.28	6.54	14.68	
	Two doses	15.5	4.02	4.23	0.39	2.19	6.32	14.26	
		31.0	4.26	4.67	0.41	2.24	6.47	15.72	
		46.5	4.93	5.2	0.47	2.35	6.74	16.05	
	Giza-843	Without	15.5	3.51	3.73	0.31	2.14	5.81	11.73
			31.0	3.66	3.86	0.34	2.23	6.11	12.65
			46.5	3.87	4.42	0.36	2.27	6.15	13.14
One dose		15.5	3.85	4.11	0.33	2.28	6.05	12.4	
		31.0	3.99	4.57	0.35	2.35	6.22	13.69	
		46.5	4.52	4.96	0.41	2.39	6.31	14.28	
Two doses		15.5	4.06	4.58	0.36	2.31	6.13	13.61	
		31.0	4.28	4.74	0.38	2.36	6.29	15	
		46.5	4.97	5.32	0.44	2.43	6.42	15.1	
L.S.D. at 5% level			0.17	0.24	n.s.	n.s.	n.s.	0.06	

treatments in straw yield/fed., as well as, protein yield/fed, were not significant ( Table7 ).

The increment in yield and its components regarding supplied faba bean plants with 46.5 Kg P<sub>2</sub>O<sub>5</sub>/fed may be attributed to the physiological role of P on the meristematic activity of plant tissues and consequently increasing plant growth, also, its function as a part of enzyme system having a vital role of the synthesis of other foods from carbohydrate.

It is worthy to mention that our results are in good agreement with those obtained by Hassanein<sup>[15]</sup>, EL-Kalla *et al.*<sup>[22]</sup>, Adam<sup>[26]</sup>, Abdalla<sup>[4]</sup> and Ahmed *et al.* <sup>[25]</sup>.

**C-4. Effect of the interaction:** Table (9) indicate that yield and its components of faba bean plants significantly affected by the interaction between cultivars × phosphorene. Generally, data illustrated show clearly that Giza-Blanka cultivar treated with Bio-P. fertilizer at two doses gave the highest

significant values from plant height, number of pods and seeds/plant, weight of pods/plant, seed yield per plant and per fed., biological yield/fed and protein yield/fed., whereas, Giza-483 cultivar treated with Bio-P. fertilizer at two doses had the greatest significant values from number of branches/plant, straw yield per plant an fed. and protein% per seeds.

Furthermore, the interaction between cultivars × P<sub>2</sub>O<sub>5</sub> fertilization rates significantly affected yield and its components of fabe bean, again, Giza-Blanka cultivar under 46.5 Kg P<sub>2</sub>O<sub>5</sub>/fed had the greatest significant values from plant height, number of pods and seeds/plant, weight of pods/plant, seed yield per plant and/or fed, biological yield/fed and protein yield/fed, meanwhile, Giza-483 plants gave the highest significant values from branches number/plant, straw yield per plant and/or fed and protein% per seeds under 46.5 Kg P<sub>2</sub>O<sub>5</sub>/fed also. (Table 9).

Regarding the interaction Bio-P. fertilizer × Mineral P. fertilizer, data illustrated in Table (9)

**Table 9:** Effect of interactions between cultivars x Phosphorene , Cultivars x P<sub>2</sub>O<sub>5</sub> and phosphorene x P<sub>2</sub>O<sub>5</sub> on yield and its components of faba bean. (Average of 2004/2005 and 2005/2006 seasons).

Interactions		Yield components										
		Plant height "cm"	No. of branches/plant	No. of pods/plant	Weight of pods/plant	No. of seeds/plant	Straw yield g/plant	Seed yield ton/fed	Straw yield ton/fed	Biological yield ton/fed	Protein% per seeds	Protein yield ton/fed
<b>Cultivars x phosphorene int.:-</b>												
Giza-Blanka	Without	112.95	3.49	42.37	51.57	78.26	49.64	1.30	1.42	2.72	17.73	0.230
	One dose	123.95	3.67	49.27	67.98	87.58	56.87	1.50	1.57	3.07	18.98	0.285
	Two doses	136.01	3.84	61.19	75.25	93.03	65.76	1.60	1.72	3.32	20.05	0.320
Giza-843	Without	102.10	3.81	36.94	47.42	72.46	52.79	1.14	1.51	2.65	19.44	0.222
	One dose	113.05	3.96	43.99	55.01	79.84	58.94	1.31	1.61	2.92	20.30	0.266
	Two doses	124.88	4.07	50.71	63.75	86.99	68.44	1.39	1.76	3.15	21.59	0.300
L.S.D. at 5 % level		3.37	0.18	1.62	1.66	1.98	1.68	0.07	0.09	0.10	0.36	0.061
<b>Cultivars x P<sub>2</sub>O<sub>5</sub> "kg/fed" Int.:-</b>												
Giza-Blanka	15.5	114.57	3.47	42.99	56.75	74.50	49.71	1.34	1.46	2.80	17.74	0.238
	31.0	125.78	3.63	50.67	66.43	87.58	59.61	1.49	1.62	3.11	18.98	0.282
	46.5	132.57	3.90	58.26	71.62	96.79	62.94	1.56	1.67	3.23	20.05	0.313
Giza-843	15.5	105.51	3.82	39.40	48.07	67.78	51.78	1.14	1.54	2.68	19.44	0.222
	31.0	113.97	3.94	45.06	55.27	80.34	62.17	1.31	1.68	2.99	20.30	0.266
	46.5	120.55	4.06	47.18	63.02	91.18	66.22	1.38	1.72	3.10	21.59	0.298
L.S.D. at 5 % level		4.11	0.15	1.73	1.80	1.95	1.74	0.09	0.10	0.10	0.40	0.064
<b>Phosphorene x P<sub>2</sub>O<sub>5</sub> Int.:-</b>												
Without	15.5	99.86	3.51	33.95	42.12	61.17	43.82	1.10	1.42	2.54	16.90	0.187
	31.0	107.42	3.58	39.46	49.23	76.29	54.15	1.25	1.46	2.71	18.06	0.225
	46.5	115.30	3.87	45.56	57.15	88.63	55.67	1.32	1.51	2.83	19.50	0.257
One dose	15.5	108.40	3.64	40.31	54.10	72.84	48.27	1.26	1.51	2.77	18.47	0.233
	31.0	121.30	3.80	46.58	61.97	84.89	60.99	1.43	1.58	3.01	19.63	0.280
	46.5	126.17	4.01	53.00	68.43	93.41	64.45	1.54	1.68	3.22	20.78	0.319
Two doses	15.5	122.22	3.80	49.34	60.77	79.42	60.15	1.38	1.57	2.95	20.41	0.282
	31.0	130.92	3.99	58.91	71.35	90.71	67.53	1.54	1.78	3.32	22.23	0.341
	46.5	128.21	4.08	59.60	76.39	99.91	73.62	1.57	1.88	3.45	22.18	0.349
L.S.D. at 5 % level		5.04	0.19	2.12	2.21	2.39	2.13	0.11	0.12	0.13	0.49	0.079

observed that the effect of this interaction on yield and its components was significant, where, the highest significant values from yield and its components were collected from plants treated with Bio-P. fertilizer at two doses and supplied with 46.5 Kg P<sub>2</sub>O<sub>5</sub>/fed.

With respect of the three-way interaction cultivars × Biofertilizer × Mineral fertilizer, data detected in Table (10) indicate clearly that the effect was

significant on yield and its components (except on straw yield/fed).

Generally, Giza-Blanka cultivar recorded the highest values from plant height, number of pods& seeds/plant, weight of pods/plant, seed yield per plant and/or per fed., biological yield/fed and protein yield/fed under two doses of phosphorene and 46.5 kg P<sub>2</sub>O<sub>5</sub>/fed., whereas, Giza-483 cultivar supplied with

**Table 10:** Effect of three - way interaction between faba bean cultivars x phosphorene x P<sub>2</sub>O<sub>5</sub> on yield and its components (Average of 2004/2005 and 2005/2006 seasons)

Cultivars	Bio-	P <sub>2</sub> O <sub>5</sub> kg/fed	Yield components												
			Plant height "cm"	No. of branches /plant	No. of pods/ plant	Weight of pods "g"/plant	No-of seeds/ plant	Seed yield g/plant	Straw yield g/plant	Seed yield ton/fed	Straw yield ton/fed	Biological yield ton/fed	Protein% per seeds	Protein yield ton/fed	
Giza-Blanka	Without	15.5	104.72	3.33	35.40	44.12	62.23	38.14	42.91	1.16	1.37	2.53	16.27	0.189	
		31.0	113.14	3.40	42.11	51.29	79.40	45.51	51.80	1.31	1.43	2.74	17.49	0.229	
		46.5	121.00	3.75	49.60	59.30	92.15	58.80	54.20	1.40	1.46	2.86	18.52	0.260	
	One dose	15.5	113.68	3.47	42.40	59.00	77.10	43.90	47.02	1.37	1.48	2.85	17.61	0.241	
		31.0	126.97	3.60	48.51	69.80	88.13	56.20	60.08	1.51	1.57	3.08	19.61	0.297	
		46.5	131.20	3.95	56.89	75.15	97.52	60.45	63.50	1.62	1.68	3.30	20.05	0.325	
	Two doses	15.5	125.31	3.62	51.18	67.14	83.18	52.19	59.20	1.50	1.55	3.05	19.33	0.290	
		31.0	137.24	3.90	64.10	78.20	95.21	64.20	66.96	1.64	1.73	3.37	20.30	0.333	
		46.5	145.50	4.00	68.30	80.40	100.70	65.40	71.12	1.66	1.87	3.53	21.58	0.357	
	GIZA-843	Without	15.5	95.00	3.68	32.50	40.11	59.10	36.21	44.72	1.03	1.46	2.49	17.52	0.181
			31.0	101.70	3.76	36.81	47.16	73.17	42.50	56.50	1.18	1.50	2.68	18.63	0.219
			46.5	109.60	3.98	41.52	55.00	85.11	47.14	57.14	1.22	1.56	2.78	20.48	0.251
One dose		15.5	102.40	3.81	38.21	49.20	68.58	41.25	49.51	1.14	1.54	2.68	19.32	0.220	
		31.0	115.62	4.00	44.65	54.14	81.64	51.17	61.90	1.34	1.60	2.94	20.10	0.270	
		46.5	121.14	4.06	49.11	61.70	89.30	52.90	65.40	1.44	1.68	3.12	21.50	0.310	
Two doses		15.5	119.12	3.98	47.50	54.40	75.66	47.61	61.10	1.26	1.60	2.86	21.48	0.271	
		31.0	124.59	4.07	53.72	64.50	86.20	56.24	68.10	1.42	1.81	3.23	22.16	0.314	
		46.5	130.92	4.15	50.90	72.35	99.12	57.30	76.12	1.49	1.90	3.39	22.78	0.339	
L.S.D. at 5% level			7.12	0.26	2.99	3.13	3.38	3.17	3.02	0.15	n.s.	0.18	0.69	0.111	

two doses of phosphorene and 46.5 kg P<sub>2</sub>O<sub>5</sub> gave the greatest values from number of branches/plant, straw yield per plant and/or fed. And protein% per faba bean seeds.

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