Evaluation of Some Agronomic and Economic Aspects of Faba Bean (*Vicia faba* L.) Under Different Soil Tillage Systems and Bio- and Chemical Phosphorus Fertilization

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ABSTRACT

Faba bean variety Giza 843 was grown at the Agricultural Research Station, Alexandria University, Egypt, during 2000/2001 and 2001/2002 winter seasons under three tillage systems [conventional (Tc), minimum (Tm) and no-tillage (Tn)], three chemical phosphorus fertilization rates [10.0 (P_1), 17.5 (P_2) and 25.0 (P_3) kg P_2O_5/fed] and two levels of phosphorin application [with (B) or without (B_0) phosphorin]. A split-split plot experimental design (three replicates) was used in both seasons.

Tillage significantly affected number of pods and seed yield per plant, 100-seed weight and seed yield/fed in the two seasons. Faba bean under conventional tillage had the highest values for these traits. Reductions, as an average of the two seasons, in seed yields for Tn were 0.56 and 1.04 ardab/fed, compared to Tm and Tc tillage, respectively. Increasing P rate was associated with significant increases in all studied characters, except for plant height and number of branches/plant, compared to P_1. Phosphorus rate of 17.5 kg/fed gave the highest values for number of pods and seed yield/plant, 100-seed weight and seed yield, in addition to cereal units/fed, whereas, further addition of P up to 25.0 kg/fed was associated with reductions in those traits, compared to P_2. Phosphorin application significantly increased the records of plant height and seed yield per plant and per fed. The second-order interaction for the three factors was significant for seed yield/fed and indicated that the response of faba bean to conventional tillage and 17.5 kg P/fed, with soil inoculation by phosphorin, in addition to conventional tillage and 25.0 kg/fed without phosphorin, produced the highest seed yield/fed for faba bean.

Regression analysis indicated a significant negative quadratic response of seed yield to phosphorus levels in both seasons and the coefficients of determination (R^2) for response were 72.0 and 76.0%, in the first season, as well as 79.8 and 84.8% in the second season, under phosphorin application either with minimum or with conventional tillage, respectively. Data concluded that phosphorin saved 48.82 and 33.92% of the maximum P level under conventional or minimum tillage, respectively, and suggested this management decision to produce the maximum seed yield and to realize the concern for environment safety.

Keywords: Faba bean, tillage, biofertilization, phosphorous.

INTRODUCTION

Faba bean, the most important winter crop in Egypt, is used mainly for human feeding (*Vicia faba* L.) and as a cheap protein source.

The primary factor affecting productivity of any crop is the cost/production relationship. Maximization of yield and reductions in yield expenses depend upon the type of and modifications in levels of cultural practices. Tillage system, bio- and chemical phosphorus fertilization are three of several important management practices. Tillage, deeper plowing with soil movement and mixing, provides suitable conditions for better plant growth and improves soil properties (Francis, 1986). No tillage, in which residues and soil are undistributed, except for a narrow seedbed, results in changes of soil physical properties. These changes can be detrimental, neutral or beneficial for crop growth and yield, with respect to other factors, such as soil texture and weed control. In general, no tillage has a greater positive effect on crop growth and yield when used in soil characterised by low organic matter levels and poor structure, rather than on well-structure soil high in organic matter (Yusuf *et al.*, 1999). Although no tillage provides substantial saving in time and labor costs (Carter and Barenett, 1987) and offers other advantages over conventional tillage under some circumstances, as water conservation (Francis, 1986), it may result in increased soil compaction and bulk density, which may negatively influence nutrients uptake and root growth leading to poor crop performance (Herridge and Holland, 1992). To avoid disadvantages of no tillage and save time for sowing a crop, reduced (minimum) tillage (upper soil layer distribution) may be an important alternative (Khalil, 1997). Responses of faba bean growth to tillage operation levels were investigated in different studies. No, negative or positive effects of no tillage treatment on faba seed yield were reported by Selim *et al.*, (1994), El-Douby *et al.*, (1996) and Gomaa and El-Naggar (1995), respectively. Meanwhile, El-Douby and Mohamed, (2002) observed a tendency for increase in seed yield, 100-seed weight, number of pods and branches/plant and plant height with tillage, compared to no tillage.

Soil supply, with phosphorus, is a very important practice for legumes, where it is considered the most important nutrient limiting pulse production. A vigorous plant growth, coupled with greater assimilates formation and translocation to plant fruiting parts, resulting in a better development for seed yield its components, are consequences for supplying legume plants with phosphorus at optimum rates (Parihar and Tripathi, 1989). However, phosphorus application of more or less than optimum was associated with a reduction in seed yield due to much rapid or late maturity at the expense of seed filling during maturity period (Yagodin, 1984). Several studies were carried out to show the effect of phosphorus application on faba bean growth aspects. Khalil (1986), El-Khawaga and Zeiton (1986) and Salem, El-Nakhlawy (1987) and El Gazzar (1993) reported that increases in P level significantly increased plant height and number of branches and pods/plants. Meanwhile, Abo-Shetaia (1990), Selim and El-Seesy (1991), Radwan (1992), El-Habbak and El-Naggar (1993), El-Douby *et al* (1996) and El-Douby and Mohamed (2002) reported increases in seed yield and yield components with the increases in P rate.

Due to the alkalinity of Egyptian soil (pH> 7), there is a restriction in gaining benefit from phosphorus fertilizer applied to soil, resulting from fixation of phosphorus fertilizer-soluble part. Therefore, soil applications with phosphorus amendments, containing bacteria active in conversion of P from insoluble to soluble status, provides phosphorus-plant needs, improves soil properties biologically and leads to increases in yields with reducing yield expenses (Ministry of Agriculture and Land Reclamation, 2003). Scarce information has been found, regarding the effect of phosphorus solublizing bacteria on plant growth aspects. Subba Rao (1982) in USA, found that soil inoculation with phosphobactrin was associated with increases in soybean yield. Saad and Hammad (1998) found that soil inoculation with P dissolving bacteria increased plant height, straw and grain yields of wheat plants.

This study was conducted to examine the basic question whether the tillage level was advantageous or not to faba bean growth performance under two cultural practices of chemical and biophosphorus fertilizers.

MATERIALS AND METHODS

A field study was conducted at the Agricultural Resereach Station, Alexandria University, Alexandria, Egypt, during 2000/2001 and 2001/2002 winter seasons for evaluation of the faba bean variety Giza 843, with regard to agronomic characters and cereal units as economic aspects. Soil chemical analysis had values of 8.4, 1.3%, 0.02% and 23 ppm for pH, organic matter, total nitrogen and available phosphorus (inorganic), respectively.

The experimental design was a split-split plot, with three replications, in both seasons. Three tillage systems; i.e., conventional tillage in the form of three passes "Tc", no tillage " Tn" and minimum tillage, cultivation of the soil upper layer, using a rotary mower "Tm", occupied the main plots. The sub-plots represented phosphorus (P) rates; i.e., P_1 = 10, P_2 = 17.5 and P_3 = 25 kg P_2O_5/fed, which were broadcasted in the form of calcium superphosphate (15.5%P_2O_5) on soil surface before sowing. The sub-sub plots were assigned to two biophosphorus treatments [with (B) or without (B_0) inoculation].

The biofertilizer phosphorin is a phosphate-solublizing bacteria (PSB) *Bacillus megatherium* var. *phosphaticum* and was provided by the Biological Amendments Project, Agriculture Research Center, Egypt. The inoculation was performed by coating faba bean seed at therate of 0.90 kg/fed using a sticking substance (Arabic gum 5%) just before sowing. The experimental unit comprised five ridges, each 4 m long and 0.6 m wide (or 12.0 m^2 in area). Seeds in a population of 140,000/fed, were sown on the two sides of ridges, in hills 20 cm apart, and thinned to two plants/hill. Sowing date was November 10^{th} in both seasons. All other practices were uniformly applied as recommended for faba bean production in the region.

The average of a sample of ten plants per plot was used to determine plant height (cm) and number of branches, pods and seed yield per plant (in grams). The mean of three 100-seed samples, from each sub-sub plot, were used to calculate 100-seed weight (in grams). The three inner ridges were harvested to calculate seed yield/plot, which was transformed to seed yield/fed, and cereal units, as economic aspects for phosphorus application. Response of faba bean seed yield over the six combinations of the three tillage systems and the two biophosphorus treatments was described in linear ($\hat{Y} = a + bx$) or quadratic ($\hat{Y} = a + bx + cX^2$) equations, where $\hat{Y}$ is the expected seed yield (kg/fed) for a given P rate, X = one unit of P and " a " is the intercept of line with Y axis, whereas, b and c are regression coefficients. Phosphorus maximum rate, with regard to quadratic equation, was worked out by the formula: $X_m = \frac{1}{2c}$ (Gomez and Gomez, 1984). Data were statistically analyzed, according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Data in Table (1) indicated that the tillage system caused significant variations for number of pods and seed yield per plant, as well as for each of 100-seed weight and seed yield/fed in both seasons. Data further revealed the significant response to chemical phosphorus levels for all studied characters, except for number of branches and pods per plant during the two seasons. The interaction of tillage systems with P level was significant for seed yield/plant and 100-seed weight in both seasons. Furthermore, data in Table (1) showed that biophosphorus significantly affected plant height, seed yield/plant and seed yield/fed in the two successive seasons.

Interactions of biophosphorus and each of tillage systems and phosphorus levels were significant for 100-seed weight and seed yield/fed in both seasons, respectively. Meanwhile, the second-order interaction for the three factors was significant for seed yield/plant, 100-seed weight and seed yield/fed in the two seasons (Table 1).

Data presented in Table (2) revealed that faba bean grown on plots of conventional tillage (Tc) produced significantly larger number of pods/plant than those obtained from minimum (Tm) and no tillage (Tn) plots in both seasons. Number of pods/plant with Tc was 1.56 and 1.89 pods more than that for Tm and Tn faba bean, respectively, as the average of both seasons. These results agreed with those of El-Metwally *et al.* (1990) and El-Douby *et al* (1996) and El-Douby and Mohamed (2002) who reported that no tillage significantly decreased the number of pods/plant. These results might be attributed to the increased mechanical resistance of zero-tilled soil to root penetration, producing shallower rooting systems along with less uptake of soil solution from soil deeper layers, compared to reduced and conventional tillages. All of these effects led to poor vegetative growth in terms of LAI (Leaf area index), which, in sequence, reduced the formation of pods and increased pod abortion.

Moreover, seed yield/plant for Tc was 0.53 and 1.15 g higher than that for Tm and Tn, in 2000/2001 season, and was 0.30 and 1.02 g higher in 2001/2002 season, respectively. Rizk *et al.* (1987) and Gomaa and El-Naggar (1995) indicated that the highest seed yield/plant was obtained from traditional tillage application. Results might be explained on the basis of the enhancement in root growth and root uptake of soil nutrients with conventional tillage, that increased physiological processes of vegetative parts towards the increase in photosynthesis and photoassimilates translocation to seeds. That was reflected into a significant increase in number of pods/plant, an important seed yield component, for Tc over both Tm and Tn, treatments.

With regard to seed yield/fed (Table 2), Tc significantly outyielded both Tn and Tm in both seasons. Percent increases in seed yield of Tc over Tm and Tn were 12.40 and 5.06%, in 2000/2001, and 15.61 and 6.90% in 2001/2002. The higher seed yield of conventional tillage might be due to its higher number of pods and seed yield per plant, compared to minimum and no tillage systems. These results were in agreement with those of Gomaa and El-Naggar (1995), El-Douby *et al.* (1996) and El-Douby and Mohamed (2002) who found that no tillage reduced faba bean total yield, compared with plowing. In a general conclusion, the positive effects of Tc might be due to better soil conditions, resulting in proper root growth and penetration, as well as better nutrients movement and availability in soil profile. On the other hand, the negative effects for Tn might be attributed to poor nutrient uptake and weak plant growth, as a result of increased soil compaction and bulk density associated with it. However, minimum tillage could be effective in critical conditions, of which is the short turn and period between faba bean sowing and removal of preceding crops.

The mean values for number of pods per plant, as affected by P levels, are presented in Table (2). It was found that such number significantly increased with increasing P levels up to 25 kg/fed in both seasons. The mean values were 10.83, 11.69 and 12.50 pods/plant, in the first season, and 11.89, 12.81 and 13.78 pods/plant in the second season, corresponding to 10.0, 17.5 and 25.0 P levels, respectively. This emphasizes the role of phosphorus in encouraging faba bean growth and increasing flowering, in addition to decreasing flower and pod abscission (Khalil, 1986). These results were in line with those reported by Selim and El-Seesy (1991), Radwan (1992) and El-Douby *et al.* (1996).

The mean values for seed yield/plant, 100-seed weight and seed yield/fed (Table 2) indicated the superiority of P_3 and P_2 over P_1 levels for such traits in both seasons. This positive effect might be due to the stimulatory effect of phosphorus on faba bean growth, especially the development of root nodules, which probably stimulated the process of symbiotic nitrogen fixation by *Rhizobium* bacteria. Such events increased photosynthesis and translocation of photoassimilates to the reproductive parts, increasing the percentage of flower and pod formation with a reduction in the abortion for each (Gradner *et al.*, 1985 and Khalil, 1986). These results were in accordance with those of Abo-Shetia (1990); El-Habbak and El-Naggar (1991), Selim and El-Seesy (1992) and El-Douby *et al* (1996) who reported that phosphorus application increased faba bean seed yield and its components. It was, generally, observed that seed yield/plant, 100-seed weight and seed yield/fed significantly increased with increasing P level up to 17.5 kg/fed, then, significantly decreased with the further increase in P level up to 25 kg/fed in both seasons. Such reductions in those traits, at the highest P level, might be attributed to the unbalanced nutrients within faba bean plants caused by the excessive amount of P uptake with the further increase in the level of P in both seasons. Cereal units, produced from 17.5 kg P_2O_5/fed were significantly higher than those of 10.0 and 25.0 kg P_2O_5, whereas, the increased addition of phosphorus up to 25.0 kg P_2O_5/fed gave significant increases in cereal units, compared to 10.0 kg P_2O_5/fed in both seasons. In conclusion, as aforementioned, the superiority of P_2 to P_1 and P_3 levels for faba bean seed yield, its attributes and cereal units indicated that such P level (17.5 kg P_2O_5/fed) was the optimum rate for faba bean growth and maximum productivity. This conclusion is in agreement with the recommendation of Ministry of Agriculture and Land Reclamation (2003) that optimum phosphorus rate for faba bean growth in heavy soil, ranged from 100 to150 kg calcium superphosphate ($P_2O_5$15.5%).

Data in Table (2), also, showed the significant differences between the treatments of inoculation and non-inoculation with P-dissolving bacteria (Phosphorin) for plant height, seed yield/plant and seed yield/fed in both seasons. Conversion of immobilized soil P to a soluble form increased plant P uptake and, consequently, the uptake of other nutrients. Such effects increased plant vegetative growth, with respect to plant height and LAI. Increases in LAI means the increase in plant photosynthesis and photoassimilates translocation to seed, increasing both seed yield/plant and seed yield/fed (Saad and Hammad 1998).

Data in Table (3) showed that seed yield/plant, 100-seed weight and seed yield/fed were significantly affected by the three-factor interaction (as shown in Table 1). Consistent and similar responses were observed for these traits to the combination treatments of tillage systems, P levels and biophosphorus applications in both seasons. Minimum tillage (Tm) produced the lowest records for such traits, when it was applied under the combination of P_1 level and B_0 treatment during the two seasons. These findings might be ascribed to improper growth conditions under no tillage reflected in restriction of the activity of P solublizing bacteria in conversion of the insoluble part of calcium superphosphate to a soluble one. These results led to less P and other nutrients uptake, thus, reducing dry matter accumulation in terms of seed yield/plant, 100-seed weight and seed yield/fed. Meanwhile, the maximum yields were obtained from P_2B and P_3B_0 combinations under the application of conventional tillage in both seasons. Improvement of soil characters for T_cP_2B and $T_cP_3B_0$ combinations increased solublization and uptake of soil phosphorus and other nutrients during seed developing and maturity, which might be reflected in greater photosynthates translocation to reproductive organs, leading to increases in pod setting, seed filling and seed yield/plant and per fed.

The response equations of seed yield to P fertilization levels under the combination treatments of tillage systems and biophosphorus applications, in both seasons, are presented in Table (4). The polynomial equations, in the two seasons, indicated that seed yield of faba bean, with each of T_nB_0, T_nB, T_mB_0, and T_3B_0 linearly increased as phosphorus fertilizer increased up to 25.0 kg/fed. The increases in seed yield, corresponding to T_nB_0, T_nB, T_mB_0 and T_cB_0, were (as an average of the two seasons) 0.032, 0.034, 0.034 and 0.106 ardab , respectively. The coefficient of determination (R^2) for faba bean linear response to phosphorus indicated that the equations explained 98.3, 96.2 and 99.6, in 2001/02, and 99.2% in 2000/01 season, as well as 96.0, 93.6, 99.6 and 99.7% of the total variation in the seed yield for T_nB_0, T_nB, T_mB_0 and T_3B_0, respectively. That finding might indicate the possibility of obtaining higher seed yield in faba bean through the application of P fertilizer levels higher than 25.0 kg/fed for the aforementioned combination treatments. Meanwhile, the response of seed yield to phosphorus, with combinations of minimum tillage with phosphorin application (T_mB), as well as conventional tillage without phosphorin application (T_cB_0), included both linear and quadratic responses with respective determination coefficients of 72.0 and 76.0%, in the first season, and 79.8 and 84.8%, in the second season, respectively. The negative quadratic coefficients indicated that increasing P level above 17.5 kg/fed. would cause progressive reduction in faba bean seed yield. The maximum P level for faba bean was 16.92 and 12.08 kg P/fed in the first season, in addition to 16.22 and 13.46 kg P/fed in the second season when grown under combination levels of T_mB and T_cB_0, respectively, suggesting that phosphorin reduced the phosphorus requirement of faba bean, in addition to the achievement of environment safety concern, when applied to conventionally tilled soil.

REFERERNCES

Abo-Shetaia, A.M.A. 1990. Yield and yield components response of faba bean (*Vicia faba* L.) to plant density and NP fertilization. Ann. Agric. Sci. Ain Shams Univ. (35): 187-204 Egypt.

Carter, P.P. and Barnett, K.H. 1987. Corn hybrid performance under conventional and minimum tillage systems. Agron. J. (79): 919-926.

El-Douby, K.A. and Mohamed, S. G. A. 2002. Effect of tillage, phosphorus fertilization and weed control on faba bean and estimation of the contribution of yield component statistically. Egypt J. Agric Res. (80): 253-274.

El-Douby, K.A. El-Habbak, K.E. Seif El-Nasr, F.M., and Basal, S.A. 1996. Effect of tillage system and plant density under different phosphorus fertilization levels on the productivity of faba bean (*Vicia faba* L.). Ann. Agric. Sci. (34): 907-918. Moshtohor, Zagazig Univ., Egypt.

El-Habbak, K.E. and El-Naggar, H.M.M. 1993. Effect of plant density and nitrogen and phosphorus fertilizer levels on faba bean. Egypt. J. Appl. Sci. (6): 214-224.

El-Khawaga, A.A.H. and Zeiton, O.A.A. 1986. Response of faba bean to four levels of nitrogen and phosphorus fertilization. I- Yield and its components. Proc. 2nd Conf. Agron., (2): 417-436. Alex., Egypt.

El-Gazzar, M.M. 1993. Yield response of faba bean to zinc and copper in connection with phosphorus application. Egypt. J. Appl. Sci., (6): 214-224.

El-Metwally, G.M.A. Abusteit, E.O., and El-Deeb, A.A. 1990. Effect of tillage systems and previous crops on some agronomic traits of faba bean (*Vicia faba* L.). J. Agric. Sci., (13): 545-549. Mansoura Univ., Egypt.

Francis, C.A. 1986. Distribution and importance of multiple cropping. Multiple Cropping Systems, Chap. 1, pp 1-20. McMillan Company, New York, U.S.A.

Gardner, P.Franklin, Peacre, R.B., and Mitchel, C. Roger 1985. Physiology of Crop Plants, Chap 3, pp. 58-75, Iwa State Univ. Press, AMES.

Gomaa, M.R. and El-Naggar, H.M.M. 1995. Faba bean yield and soil properties as affected by various tillage practices and weed control management. Ann. of Agric. Sci., (33): 1195-1209. Moshtohor, Zagazig Univ. Egypt.

Gomez, K.A. and Gomez, A.A. 1984. Statistical Procedures for Agricultural Research 2nd ed. John Willy and Sons, New York, U.S.A.

Herridge, P.F. and Holland, J.C. 1992. Production of summer crops in Northern New South Wales. 1. Effect of tillage and double cropping on growth, grain yield and N yields of six crops. Aust. J. Agric. Res. (43): 105-122.

Khalil, H.E. 1986. Some factors affecting growth characters of faba bean. M. Sc. Thesis, Faculty of Agriculture, Alexandria University, Alexandria, Egypt.

Khalil, H.E. 1997. Evaluation of agronomic and economic aspects of sunflower under soil tillage practices and phosphorus application. Adv. Agric. Res., (2): 67-77.

Ministry of Agriculture and Land Reclamation 2003. Faba bean cultivation. Bulletin No. 828, Issued by Central Administration of Extension Service, Agric. Res. Cent., Ministry of Agric., Egypt.

Parihar, S.S. and Tripathy, R.S. 1989. Dry matter, nodulation and nutrient uptake in chickpea (*Cicer arietinum* L.) as influenced by irrigation and phosphorus. Exp. Agric. (25): 349-355.

Radwan, F.I. 1992. The effect of phosphate fertilizer and weed control methods on growth and yield of faba bean (*Vicia faba* L.). Ann. Agric. Sci. (30): 1191-1205. Moshtohor, Egypt.

Rizk, M.A. El-Borai, M.A., and saber, H.A. 1987. Response of faba bean (*Vicia faba* L.) to some fertilizer treatments under tillage and zero tillage systems after rice. J. Agric. Res. (13): 747-755.Tanta Univ., Egypt.

Saad, O.A.O. and Hammad, A.M.M. 1998. Fertilizing wheat plants combined with phosphate dissolving bacteria and VA-mycorrizae as alternative for Ca-superphosphate. Ann. Agric. (43): 445-460. , Ain Shams Univ., Cairo, Egypt.

Salem, S.A. and El-Nakhlawy, F.S. 1987. Effect of application of nitrogen and phosphorus fertilizer levels on seed yield, its components and other characters in faba bean (*Vicia faba* L.). Alex. J. Agric. Res. (32): 139-148.

Selim, M.S.M. Kamel, A.S. Shrief, I.M., and Al-Mashed, L.A. 1994. Effect of tillage and weed control treatments on weeds, yield and attributed traitsof faba bean. Zagazig J. Agric. Res., (21): 767-776.

Selim, M.M. and El-Seesy, M.M.A. 1991. Productivity of faba bean as affected by plant population, phosphorus fertilization and sowing methods. Egyptian J. Agron. (16): 239-251.

Subba Rao, N.S. 1982. Biofertilizers in Agriculture. Chap, 7, pp. 128-137. Oxford and IBH Publishing Co.

Yusuf, I.R. , Simens, C., and Bullock, D.G. 1999. Growth analysis of soybean and no tillage and conventional tillage systems. Agron. J. (91): 928-933.

Yagodin, B.A. (1984). Agricultural Chemistry. Vol. 1 p 293-343. Mir Publishers, Moscow.

Table 1. Mean squares of studied characters in 2000/2001 and 2001/2002 seasons.

S.O.V	d.f.	Plant height (cm)		Number of branches/plant		Number of pods/plant		Seed yield/plant (g)		100-seed weight (g)		Seed yield Ardab/fed		Cereal units	
		2000/01	2001 / 02	2000/01	2001 / 02	2000/01	2001 / 02	2000/01	2001 / 02	2000/01	2001 / 02	2000 /01	2001 / 02	2000/01	2001 / 02
Tillage systems (A)	2	11.7	10.4	0.70	0.63	11.6*	17.64*	5.99*	4.88*	194.4*	235.6*	3.97*	5.84*	12.9	11.03
Error (a)	4	3.40	3.82	0.128	0.136	1.10	1.92	0.08	0.09	5.88	8.89	0.03	0.03	6.26	5.80
Chemical phosphorus (B)	2	14.05*	9.95*	0.087	0.097	2.64	3.98	3.84*	3.67*	169.24*	220.9*	3.98*	4.12*	10.69*	13.10*
A x B	4	6.12	4.58	0.03	0.03	0.16	0.91	1.70*	1.20*	24.66*	19.00*	0.190	0.163	0.23	0.36
Error (b)	12	3.88	2.82	0.015	0.062	0.432	0.898	0.033	0.022	1.91	3.84	0.123	0.158	0.189	0.165
Biophosphorus (C)	1	34.15*	31.26*	0.33	0.22	0.22	0.240	3.07*	3.50*	2.30	1.56	6.24*	8.72*	0.119	0.28
A x C	2	7.88	7.96	0.22	0.20	0.04	0.040	0.17	0.19	7.35*	10.8*	0.05	0.04	1.533	1.35
B x C	2	7.07	7.67	0.18	0.19	0.01	0.099	0.12	0.21	6.80	6.22	2.19*	0.71*	0.32	0.23
A x B x C	4	6.03	5.75	0.18	0.22	0.102	0.097	0.42*	0.43*	6.80*	9.66*	1.111*	0.873*	0.36	0.26
Error (c)	18	2.35	2.43	0.28	0.39	0.219	0.342	0.052	0.077	2.04	2.90	0.062	0.027	0.90	0.83

* Significantly different at 0.05 probability level.

Table 2. Mean values of studied characters as affected by tillage systems, chemical phosphorus and biophosphorus in 2000/2001 and 2001/2002 seasons.

Treatments	Plant height		Number of branches/plant		Number of pods/plant		Seed yield/plant		100-seed weight		Seed yield/fed		Cereal units	
	2000/01	2001/02	2000/01	2001/02	2000/01	2001/02	2000/01	2001/02	2000/01	2001/02	2000/01	2001/02	2000/01	2001/02
Tillage systems														
T_n	115.83	117.70	2.63	2.64	11.06	11.96	8.14	7.84	42.39	44.56	7.58	7.24	13.65	13.04
T_m	115.89	117.78	2.63	2.66	11.39	12.29	8.67	8.14	45.50	48.00	8.11	7.83	14.59	14.10
T_c	116.00	117.84	2.65	2.70	12.58	14.22	9.29	8.86	49.00	52.72	8.52	8.37	15.34	15.09
L.S.D. 0.05	n.s.	n.s.	n.s.	n.s.	0.97	0.34	0.26	0.28	2.24	2.76	0.16	0.16	n.s.	n.s.
Chemical phosphorus														
P_2O_5														
10.0 (P_1)	115.22	117.61	2.61	2.64	10.83	11.89	8.18	7.71	44.39	42.17	7.60	7.29	13.68	13.14
17.5 (P_2)	115.89	117.78	2.63	2.66	11.69	12.81	9.06	8.66	51.67	48.00	8.32	8.11	16.97	16.81
25.0 (P_3)	116.50	127.89	2.64	2.70	12.50	13.78	8.87	8.47	49.22	46.72	8.29	8.08	16.53	16.20
L.S.D. 0.05	n.s.	n.s.	n.s.	n.s.	1.05	1.10	0.132	0.108	1.01	1.42	0.254	0.29	0.32	0.30
Biophosphorus														
B_0	115.07	116.37	2.57	2.63	11.66	12.79	8.44	7.93	48.24	45.36	7.82	7.41	14.52	14.05
B	116.67	119.15	2.68	2.70	11.69	12.86	8.94	8.63	48.61	45.80	8.32	8.22	14.55	14.10
L.S.D. 0.05	0.88	0.89	n.s.	n.s.	n.s.	n.s.	0.13	0.16	n.s.	n.s.	0.14	0.10	n.s.	n.s.

n.s. = Not significant

Table 3. Mean values of faba bean as affected by tillage systems x P levels x phosphorin interaction in 2000/01 and 2001/02 seasons.

	Seed yield/ plant (g)						100- seed weight (g)						Seed yield/fed (ardab)					
	P_1		P_2		P_3		P_1		P_2		P_3		P_1		P_2		P_3	
	B_0	B	B_0	B	B_0	B	B_0	B	B_0	B	B_0	B	B_0	B	B_0	B	B_0	B
2000/2001																		
T_n	7.57	7.93	7.97	8.30	8.43	8.67	39.67	42.00	43.67	46.67	45.67	49.67	7.07	7.33	7.50	7.73	7.90	7.97
T_m	8.33	8.53	8.43	9.00	8.63	9.10	44.00	46.67	47.67	53.67	50.33	50.67	7.63	7.97	7.79	8.60	8.23	8.23
T_c	8.13	8.60	9.60	10.0	10.17	9.27	44.33	49.67	54.67	53.67	54.67	53.30	7.60	8.00	8.50	9.64	9.73	7.67
L.S.D. $_{0.05}$	0.39						2.18						0.14					
2001/2002																		
Tn	7.27	7.57	7.53	8.13	8.87	8.87	38.00	41.00	41.67	44.33	43.67	45.67	6.85	6.98	7.03	7.23	7.30	8.07
Tm	7.30	8.30	7.33	8.80	8.30	8.80	42.00	44.00	44.00	50.33	45.67	47.00	7.10	7.80	7.27	8.47	8.10	8.27
Tc	7.67	8.47	9.57	9.13	9.20	9.10	42.67	45.33	48.33	52.56	54.10	51.00	7.27	8.03	7.87	9.20	9.27	8.60
L.S.D. $_{0.05}$	0.48						1.75						0.28					

Table 4. Response equation of seed yield to P fertilization under different combinations of tillage systems and phosphorin application in 2001/01 and 2001/02 seasons.

Treatment combination	2000/01		2001/02	
T_nB_0	$\hat{Y} = 6.71 + 0.038\,X$	$R^2 = 98.3\%$	$\hat{Y} = 6.21 + 0.025\,X$	$R^2 = 96.0\%$
T_nB	$\hat{Y} = 7.04 + 0.032\,X$	$R^2 = 96.2\%$	$\hat{Y} = 7.44 + 0.035\,X$	$R^2 = 93.6\%$
T_mB_0	$\hat{Y} = 7.34 + 0.030\,X$	$R^2 = 99.6\%$	$\hat{Y} = 6.69 + 0.037\,X$	$R^2 = 99.6\%$
T_mB	$\hat{Y} = 8.22 + 0.00132\,X - 0.000039X^2$	$R^2 = 72.0\%$	$\hat{Y} = 8.90 + 0.0012\,X - 0.000037X^2$	$R^2 = 79.8\%$
T_cB_0	$\hat{Y} = 6.45 + 0.109\,X$	$R^2 = 99.2\%$	$\hat{Y} = 6.11 + 0.102\,X$	$R^2 = 99.7\%$
T_cB	$\hat{Y} = 8.40 + 0.0290\,X - 0.0012X^2$	$R^2 = 76.0\%$	$\hat{Y} = 8.57 + 0.035\,X - 0.0013X^2$	$R^2 = 84.8\%$

T_n, T_m and T_c = No, minimum and conventional tillage, respectively.

B_0 and B = No inoculation and inoculation with phosphorin, respectively.

الملخص العربى

تقويم بعض الصفات المحصولية والنواحى الاقتصادية فى الفول البلدى تحت نظم خدمة التربة والتسميد الفوسفورى العضوى والمعدنى

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أجريت هذه الدراسة بمحطة البحوث الزراعية - كلية الزراعة - جامعة الإسكندرية خلال الموسمين الشتويين ٢٠٠٠/٢٠٠١ و ٢٠٠١/٢٠٠٢ لدراسة تأثير ثلاثة نظم لخدمة التربة [حرث تقليدى و حرث سطحى و بدون حرث] وثلاثة معدلات للتسميد الفوسفورى الكيماوى (١٠,٠- ١٧,٥ - ٢٥,٠ كجم فو٢أ٥/ فدان) ومعدلين للفوسفورين (إضافة وبدون إضافة) على السلوك المحصولى ووحدات الحبوب لصنف الفول البلدى "جيزة ٨٤٣" وقد استخدم تصميم القطع المنشقة مرتين (ثلاث مكررات) فى الموسمين. وقد دلت الدراسة على :-

١-أ- التفوق المعنوى للحرث التقليدى على طرق الحرث الأخرى فى صفات عدد القرون والمحصول البذرى بالنبات ، وزن المائة بذرة والمحصول البذرى بالفدان.

ب- أدت مستويات الخدمة السطحية او دونها الى النقص فى المحصول البذرى مقارنة بالحرث التقليدى بما يعادل ٠,٥٦ و ١,٠٤ اردب/ فدان (كمتوسط للموسمين).

٢-أ- أدت زيادة وحدات الفوسفور حتى ٢٥ كجم/ فدان الى الزيادة المعنوية فى كل الصفات المدروسة ما عدا صفتى ارتفاع النبات وعدد القرون بالنبات.

ب- زيادة وحدات الفوسفور حتى ١٧,٥ كجم/ فدان حققت أعلى زيادة معنوية لكل من عدد القرون والمحصول البذرى بالنبات ووزن المائة بذرة والمحصول البذرى ووحدات الحبوب بالفدان.

٣- أدى اللقاح البكتيرى للتربة الى زيادة معنوية فى ارتفاع النبات والمحصول البذرى بالفدان.

٤- أعطى استخدام الحرث التقليدى مع إضافة ٢٥ وحدة فوسفور دون التلقيح البكتيرى ، وكذلك استخدام الحرث السطحى مع إضافة ١٧,٥ وحدة فوسفور مع استخدام اللقاح البكتيرى اعلى القيم فى المحصول البذرى بالفدان ، مع ترشيد استهلاك التسميد الفوسفاتى بمقدار الثلث او النصف على التوالى.