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RESPONSE OF SOME FABA BEAN CULTIVARS TO DIFFERENT LEVELS OF PHOSPHORUS FERTILIZER WITH INOCULATION BY PHOSPHORUS SOLUBILIZING FUNGI

Abbas, E . E. * ; M. M. El-Metwally and M.R. A. Mohamed *****
*** Field Crops Research Institute, Agric.Res. Center, Giza , Egypt**
****Department of Botany , faculty of Science, Damanhour, Univ.**
*****Soil, water& Envie. Res . Institute, A. R. C, Giza** , Egypt

ABSTRACT

Phosphorus (P) is considered limiting factor for growth and productivity of legume crops . Two field experiments were conducted at the experimental Farm of Tag El- Ezz Station, Dakahlia Governorate ,Egypt during 2010/2011 and 2011/2012 seasons, to study the productivity of three faba bean cultivars namely (Sakha 1, Nubria 1 and Giza 843) under three phosphorus levels, i.e. (15.5, 23.25 and 31Kg P2O5/fad.)with three types from solubilizing phosphate fungi ,i.e. (*Aspergillus Oryza, Aspergillus Niger and Penicillium Purpurogenum*). The results indicated that there were significant differences among the tested varieties in most characters studied in both seasons and combined analysis. Sakha 1 gave the highest values of nodules and root weight compared with other cultivars. Adding super phosphate at the rate of 31 kg P2O5 gave the highest values of nodules and roots weight compared with the other phosphorus levels and using fungi *A .Niger* recorded increase in nodules and root weight after 45 and 60 days from sowing in both seasons. On the other hand, growth and yield attributes as well as seed yield /fad. were significantly increased with the increase of phosphours level from 15.5 to 31 kg P2O5/fad. Inoculation faba bean seeds with *A. Niger and A. Oryza* gave the highest values for seed yield and yield attributes for all faba bean varieties in both seasons and combined analysis . on the other hand Sakha 1 produced the highest seed yield .(8.18, 8.28 and 8.23 ardab/fad.) compared with 7.83 ,8.03 and 7.93 ardab/fad. for Nubria 1 and (8.02,8.25 and 8.15 ardab/fad.) for Giza 843 in both seasons and combined analysis respectively. The results obtained revealed that , there are significant differences in P% values , between studied cultivars , Sakha 1 gave the highest values compared with the other cultivars . On the other hand, adding 31 Kg P2O5 and the inoculation with *A. Niger* gave the highly significantly P% in roots and shoots in both seasons . Also the interactions effect between all studied factors on P% in root and shoot are highly significantly in both seasons

Keywords : Faba bean, , nodulation, inoculation, phosphours , phosphorus solubilizing fungi and Phosphorus percentage .

INTRODUCTION

Faba bean (*vicia faba L.*) is one of the most important food legume crops in Egypt .It is primary a source of vegetable protein and carbohydrates in human food and animal feed .In addition, straw yield of faba bean are used for animal feeding, and it plays a role in crop rotation . However, the total production of this crop is still insufficient to cover the local consumption. Therefore, there is a greet need to overcome this gab between local production and consumption demand by expansion through reclaimed areas which represent the most hope of cultivated lands in increasing our agricultural production and subsequently in overcoming the deficiency in food

requirement, as well as increasing the vertical production through introduction of new varieties with high potential such as Sakha 1, Nubria 1 and Giza 843 which giving high seed yield and resistant for diseases, Ashmowy, et al,1999;Bakheit . et al , 2001; Abou-Taleb,2002; Hussein, et al ,2005 and Khafage, et al ,2009.

Many factors are affecting the production of faba bean plants. Phosphorus is the most important nutrients because the least mobile and low available to plants in most soil conditions . Although phosphorus is abundant in soils in both organic and inorganic forms, of phosphorus fertilizers , part of which is utilized by plants and the remainder converted into fixed forms . Phosphate-solubilizing microorganisms (PSM) could play an important role in supplying phosphate to plants in a more environmentally-friendly and sustainable manner, Abdel - Aziz, et al , 1987; Abdel - Reheem et al., 1993; Abo-Salama and Dawood, 1994;Hammam 1995 a ; Hammam 1995 b and El-Douby ,et al.,1996).

Important genera of phosphate solubilizing fungi are *A .Oryza, A. Niger and P. purpurgenium*. Certain strains of Rhizobium can also solubilizing both organic and inorganic phosphates . This ability is generally associated to the release of organic acids decreasing the pH. Moreover these organic acid can increase considerably P in the soil solution through the quotation of Ca, Fe and Al. Change reaction and solubilization of low soluble salts. The inoculation of P-solubilizing microorganisms is a promising technique because it can increase P availability in soils fertilized with rock phosphates. Several authors reported yield increase for wheat, onion, soybean and vicia faba, through inoculation of P-solubilizing fungi (PSF). Inoculation of phosphate solubilizing fungi and mycorrhizal fungi improve the physic-chemical, biochemical and biological properties of rock-P amended soil .Beyond the phosphate solubilization, many microorganisms increase the mycorrhizal root colonization by production of specific metabolites as vitamins, amino acids and hormones .Singh and Amborger (1998) reported that the use of phosphate solubilizing microorganisms increasing thr efficiency of rock phosphate and super phosphate applied in neutral to alkaline soils . Phookan and Shadeuqe (1994) reported that the application of phosphours along with Rhizobium inoculation improved the yield and quality of pea. It has also been reported that the available P and aggregate stability levels, higher soil C level , enzyme activates and lower soil pH are related with PSM inoculation. The objective of this work is to evaluate solubilization ability of insoluble phosphates by several fungi isolates and their effect up on growth of faba bean plants .

MATERIALS AND METHODS

Two field experiments were carried out during 2010/2011 and 2011/2012 seasons in the Experimental Farm, Tag El- Ezz Station, Dakhalia Governorate, Egypt, to study the performance of some faba bean cultivars, i.e. Sakha 1, Nubria 1 and Giza 843 to phosphorus fertilization doses and the

inoculation with three types from fungi, i.e. *A. Oryza, A. Niger and P. purpurgenium* , isolated from experimental site Tag El –Ezz.

A split-split plot design with three replicates was utilized . The main plots were devoted to the three faba bean cultivars, i. e Sakha 1, Nubria 1 and Giza 843, its chosen from faba bean germplasm collection in food legumes Research Station, Agricultural Research Center, Giza Egypt. The sub –plots were occupied by the following three phosphorus levels (15.5, 23.25 and 31kg P2O5 /fad.), while the sub-sub plots were assigned to the three types of phosphorus Solubilizaing fungi , i.e.(*A. Oryza, A .Niger and P. Purpurogenum*). Each sub-sub plots included 5 ridges. Occupying an area of 10.5m2 (3.5 x 3 m). Calcium super phosphate (15.5 % P2O5) was applied during soil preparation as previous mentioned . The preceding crop was rice (*Oryza sativa L.*) in both seasons . Faba bean cultivars were planted at Nov. 20th and 22th in the first and second seasons , all cultural practices including , nitrogen and potassium fertilization were performed as recommended methods .The inoculated seeds by fungi were sown and irrigated at the same agriculture .

Soil sample of the experimental trial was air-dried, ground and passed through a 2mm sieve. Particle – size distribution was determined by international method (Piper 1950). The soil of trial field was clayey texture, non-saline (ECe 2.57dSm-1), PH (8.15), Esp (8.140) , CaCO3 (2.50%) and organic matter (1.60%), all chemical analysis were determined according to Richared (1954). Available phosphorus was (3 ppm), while was determined according to Black (1982) .

= Isolation and screening of phosphorus solubilizing fungi isolates :

Sterilized Pikovskaya (PVK) agar medium g/l (glucose, 10;Ca3(PO)4 5;(NH4)2SO4. 0.5 NaCl, 0.2; MgSO4. 7H2O, 0.1 Kcl 0.2; yeast extract 0.5; MnSO4 . 7HO, 0.002; FeSO4 . 7H2O, 0.002 and agar 15 (Pikovskaya, 1948), was poured into sterilized Petri plates. After solidification, the media inoculated by soil suspension of three alkaline and cultivated soil samples from three locations in Dakahlia district, Egypt (Tag El- Ezz, Mansoura and Manzalah). After incubation at 28+2*C for 7days, the halo zone formation around the growing colony showing phosphate solubilization. Solubilization index was evaluated according to the ratio of the total diameter (colony + halo zone) and the colony diameter

= Inoculums preparation and soil inoculation :

The three most active isolates were selected and cultivated in potato dextrose broth. g/l (potato, 200 and 20, dextrose) for 10 d at 28+ 2*C. The medium vigorously shacked for 30 min at 250 rpm. Ten milliliters of 10 spore/ml from each fungi species were applied. Inoculation for seeds before sowing .

The most active fungi species used in this study.

Aspergillus Oryza (Ao) Aspergillus Niger (An) Penicillium Purpurogenum (Pp)

After 45 and 60 days from sowing, 10 guarded plants were taken from each plot to estimate the nodules and shoot weight /gram.

At harvest, 10 guarded plants were taken from each plot to estimate the following characters :

1- Plant height (Cm).
2- Number of branches/plant
3- Number of pods/plant
4- 100-seed weight (g.)
5- seed weight (g.)/plant
6- Seed yield (ardab/fad.)

Statistical analysis :

The collected data were statistically analyzed according to the technique of analysis of variance for combined in a split – split plot design by means of "Co-stat" computer software package, the least significant difference (LSD) method was used to test the difference between treatment means at 5% probability, as published by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1- Nodulation and root weight :

1- 1. Effect of varieties

Data in Table 1. Showed significant differences between the three faba bean varieties on all measured characters, Sakha 1 gave the highest values of nodules and root weight (g.) after 45 and 60 (DFS) in both seasons, except nodules weight (g) after 60 (DFS) in the second season. While Nubria 1 variety recorded the lowest values for these parameters after 45 and 60 (DFS) in both seasons. Also Sakha 1 variety surpassed Nubria 1 and Giza 843 varieties in nodules and roots weight (g.) after 45 and 60 (DFS) by (31;1, 31; 11; 16; 4; 29 and 8%, respectively in the first season, and (40;7 ; 17 ; 13 20; 4; 31; and 8%) for nodules and root weight in the second season , respectively . Several workers reported that faba bean varieties differed widely in their growth characters ability, Hamada , 1992; Zeidan,1998 and Hussein, et al,2005 .

2-1. Effect of phosphorus fertilization :

Nodules and roots weight of faba bean as affected by phosphorus fertilization are presented in Table 1 : Data showed that increasing phosphorus fertilizer from 15.5 to 31 kg P2O5/fad. Increased nodules and roots weight after 45 and 60 days from sowing in both seasons, phosphorus fertilizer at 31 kg/fad. gave the highest values of nodules and roots weight compared with 15.5 and 23.25 kg P2O5/fad. in both seasons .This results are in agreement with those obtained by Bochniarz, et al., 1987;Hassanein ,1995;Chizaw. et al , 1999 and Iman and Azouni ,2008.

3-1. Effect of phosphorus solubilization fungi :

Data in table 1, show that the inoculation faba bean seeds by *A. Niger and A. Oryza* gave the highest values of nodules and roots weight compared with the control and P. purpurgenium. Roots weight at 45 (DFS) did not significantly differ than the other two types of fungi . These results are in agreement with Salem and Massvi ,1986 b; Tallarico and Ovsi ,1988 ; Phookan and Shadeque , 1994; Hammam ,1995 b; Ragab 1998; El-Sayed ,1999 and Aftab Afzal Asghari Bano ,2008.

4- 1.The interaction effect :

The interaction between faba bean varieties and phosphorus levels was significant for most traits tested in both seasons .

Table 2 , indicated that the three faba bean varieties differed in their response to the different fertilizer treatments . Sakha 1 and Giza 843 gave the maximum nodules weight after 45 and 60 (DFS) by the application of 31 kg P2O5/fad.

Table 3 , indicate that the two fungi types *A. Oryza and A. Niger* gave the maximum nodules weight after 45 and 60 (DFS) with Sakha 1 and Giza 843 compared with *P. purpurgenium* type. On the other hand Nubria 1 gave the lowest values of nodules weight compared to Sakha 1 and Giza 843.

Table (1). Weight of faba bean nodules and roots as affected by faba bean varieties , P fertilization and P solubilizing fungi after 45 and 60 (DFS) g in 2010/ 2011, 2011/2012 seasons and combined analysis .

Seasons	2010/2011				2011/2012			
Characters	Nodu-w.after 45 days	Roots w. after 45 days	Nod-w. after 60 days	Roots w. after 60 days	Nod-w. after 45 days	Roots w. after 45 days	Nod-w. after 60 days	Roots w. after 60 days
A-Varieties								
a1-Sakha 1	0.33	22.97	0.41	36.77	0.31	22.86	0.35	36.02
a2- Nubria 1	0.26	19.82	0.32	28.49	0.22	19.07	0.30	27.66
a3- Giza 843	0.30	22.18	0.38	34.20	0.29	22.02	0.31	33.37
F-test	*	*	*	*	*	*	ns	*
LSD	0.01	0.82	0.02	2.65	0.02	0.89	---	1.04
B- Phosphorus L.								
b1- 15.5 kg/fad.	0.27	19.4	0.35	30.98	0.25	18.36	0.29	30.41
b2- 23.25kg/fad.	0.29	21.69	0.37	32.50	0.27	21.08	0.33	31.85
b3-31 kg/fad.	0.33	24.15	0.39	35.98	0.30	24.51	0.35	34.79
F- test	*	*	*	*	*	*	ns	*
L S D	0.01	0.43	0.01	1.99	0.01	0.62	----	0.66
C-Bacteria types.								
c1-control	0.17	15.97	0.23	25.52	0.16	15.41	0.29	24.34
c2-A.oryza	0.35	22.84	0.42	35.34	0.30	22.83	0.33	35.68
c3-A.niger	0.35	22.91	0.44	37.20	0.34	24.79	0.33	36.93
c4-P.purpur-	0.31	24.91	0.40	34.55	0.29	22.28	0.32	32.45
F-test	*	*	*	*	*	*	ns	*
LSD	0.01	0.55	0.01	2.25	0.03	0.62	---	0.69
D- Interaction.								
d1- AxB	*	*	*	ns	*	*	ns	ns
d2- AxC	*	*	*	ns	*	*	ns	*
d3- Bx C	*	*	ns	ns	ns	*	ns	ns
d4- A x B x C	*	ns	*	ns	ns	ns	ns	ns

Table (2): Nodules weight after 45 and 60 (DFS) as affected by the interaction between faba bean cultivars and phosphorus levels in 2010/2011 season

Seasons	2010/2011					
Characters	Nodules weight after 45 (DFS)			Nodules weight after 60 (DFS)		
P. Levels	15.5 kg/fad	23.25 kg/f.	31kg/fad.	15.5kg/fad.	23.25kg/fa.	31kg/fad.
Sakha 1	0.28	0.34	0.38	0.37	0.42	0.46
Nubria 1	0.23	0.24	0.27	0.32	0.31	0.32
Giza 843	0.29	0.29	0.33	0.35	0.39	0.39
F- test	*			*		
LSD	0.01			0.02		

Table (3): Nodule weight after 45 and 60 (DFS) as affected the interaction between faba bean varieties and the solubilizing phosphorus fungi in 2010 and 2011 seasons .

Seasons	2010/ 2011					
Characters	Nodules w. after 45 (DFS)			Nodules w-after 60 (DFS)		
Cultivars	Sakha 1	Nubria 1	Giza 843	Sakha 1	Nubria 1	Giza 843
B- Types						
Control	0.17	0.14	0.19	0.25	0.20	0.25
A. oryza	0.41	0.29	0.35	0.50	0.35	0.41
A. niger	0.40	0.30	0.35	0.49	0.37	0.46
P. purpur-	0.36	0.26	0.32	0.44	0.35	0.40
F-test	*			*		
LSD	2.18			1.52		

2- Growth characters :

1- 2. Effect of varieties .

Data of plant height and number of branches/plant of faba bean varieties were recorded in Table 4 : Data showed that there were significant differences between the three tested varieties for plant height and number of branches/plant, this was true in both seasons and combined analysis . Giza 843 variety gave the highest plant height than Sakha 1 and Nubria 1 cultivars, the percentage were 12, 28,18.31, 12 and 29% over Sakha 1 and Nubria 1 in both seasons and combined analysis respectively . On the other hand Nubria 1 cultivar predicted the highest number of branches/plant than Sakha 1 and Giza 843 the percentage increase were (21 ; 29, 28 ; 54, 20 and 40%) in both seasons and combined analysis respectively . These results are inline with those reported by Ashmowy, et al., 1999;Bakheit, et al., 2001; Abou Taleb, 2002 and El-Hindi. et al., 2008 .

2-2. Effect of phosphorus fertilizers:

From table 4 , The data clearly showed that increasing phosphorus fertilizer from 15.5 to 31 kg P2O5/fad. lead to significantly increase in plant height and number of branches/plant, the rate of 31 kg P2O5 gave the maximum plant height and number of branches/plant in the first and second seasons and combined analysis In general applying phosphorus gave the highest values of plant height and number of branches/plant compared with control. Abdel- aziz, et al., 1987; Abdel Reheem.et al., 1993; Abou salama and Dawood ,1994;Ibrhaim and Esmial , 1994; Hammam , 1995 a and El-Douby. et al., 1996, stated that the role P of enhancing plant growth may be due to photosynthesis and metabolic formation.

3-2. Effect of phosphorus solubilization fungi :

From Table 4 , data recorded the highest values of plant height and number of branches/plant occurred under the application of *Aspergillus Niger* strain than the *Aspergillus Oryza* , *Penicillium purpurgenium* and the control treatment , the percentage increases were 5; 7;11 ; 6; 10; 17; 7; 9 and 12% respectively on the other hand the percentage increase for number of branches/plant were 10; 19 ; 26;10 ; 19 ;19; 10 ;19 and 30% for *A. Niger* over *A. Oryza* , *P. purpurgenium* and the control in both seasons and combined, analysis respectively . Similar observation have bean reported by several others such as, Mehana and Abdul Wahid, 2002; Tyagi. et a., 2002;

Aftab Afzal and Asghari Bona, 2008 and Iman and El-Azouni, 2008. They reported that, there is a demand on studies on this subject, in order to improve the functional knowledge of compatibility of those microorganisms aiming at their co- inoculation to increase the nutrition and growth of plant species

3 - Yield attributes :

1- 3. Effect of varieties :

Data of yield and yield attributes of faba bean varieties are presented in Table 5 : Data showed that, there were significant differences between the three tested varieties for yield attributes. This was true in both seasons and combined analysis. Sakha 1 cultivar resulted in the highest number of pods/plant(23.09%) compared with Nubria 1,(20.28) and Giza 843 (19.63) cultivars , in the average of both seasons . The sesame trained for seed weight/plant . These resulted on seed yield per Fad. Were, Sakha 1 cultivar gave the highest values in seed yield/fad. compared with Nubria 1 and Giza 843 cultivars. This increase may be attributed to the improvement in growth characters of Sakha 1 cultivar, Similar differences between faba bean cultivars was observed in seed yield by Hamada , 1992 ; Hassanein, 1995; Ashmawy et al., 1999; Bakheit et al.,2001; Abou- Taleb,2002 and Hussein et al., 2005.

2-3. Effect of phosphorus fertilizer :

Data in Table 5. Showed that, a marked differences were detected among three phosphorus levels on all characters of faba bean. Phosphorus level 31kg P2O5/fad. recorded the highest values of number of pods/plant, 100- seed weight, seed weight/plant and seed yield/fad. The increase in number of pods/plant was recorded (20 ; 17 , 18; 9 ,19 and 13 %) in both seasons and combined, analysis . On the other hand , increasing in phosphorus level to 31kg P2O5/fad. gave the highest values of seed yield/fad. compared with the other levels 15.5 and 23.25 P2O5/fad. where the increase reached to 7 ; 3, 7; 4 7 and 4%) in both seasons and combined, analysis, respectively . This results may be attributed to the role of P in enhancing photosynthesis and metabolic processes . Moreover number of pods/plant, 100-seed weight and seed weight /plant were increased by increasing P level which reflects directly on the yield. This may be due to the phosphorus fertilizer encouraged the vegetative growth plant, flowering and fruiting of three faba bean cultivars .These results are in agreement with those obtained by Salem and Massri, 1986 b; Hamada et al., 1992; Majumdar et al ., 1994; Hassanein,1995; El- Douby et al ., 1996 ; Saad and El- Kholy, 2001 and Aftab Afzal and Asghari Bano,2008 .

3-3. Effect of solubilization phosphorus fungi :

Table (5) : Indicted that the application of *A. Niger* type to zone roots gave the highest significantly increases for number of pods/plant, 100-seed weight, seed weight/plant and seed yield/fad. compared with the other types of fungi *A. Niger* treatment gave the highest values for seed yield/fad., the percentage increase were 6 ; 10 ; 13; 7 ; 11 ; 14 ; 7;10 and 10% compared with the other fungi types and untreated treatment in both seasons and combined analysis ; respectively. These results could be partially attributed to the relatively higher ability of that fungus to increase the available P in the

soil . Similar results was observed by, El- Sayed ,1999; Mehana and Abdul Wahid ,2000; Tyagi et al, 2002 and Iman and Azouni , 2008. They reported that the used phosphate dissolving fungi (PDF) can be arranged, in a descending order , according to there effect on the total uptake of P. But the total uptake of P the arrangement will be P. pinophlium *A. Oryza* and *A. Niger*. The highest enhancement effect of P. pinophlium on P Uptake was reported in wheat and faba bean plants fertilized with either super-phosphate or rock phosphate.

4- Interaction effect :

The interaction between faba bean cultivars and phosphorus levels were significant for most traits studied in both seasons except of seed weight/plant and seed yield/fad. The results in Table 6 , indicate that Giza 843 and Sakha 1 gave the maximum seed weight /plant and seed yield/fad. by the application of 31 kg P2O5/fad. in both seasons . While Giza 843 gave the highest seed weight /plant 17, 03 and 17; 37 g and seed yield/fad. 8.52 and 8.68 ardab/fad. with the application of 31 kg P2O5/fad. in both seasons respectively.

The results in Table 7, indicate that .Giza 843 gave the maximum seed weight/plant by the application of 31 kg P2O5/ fad. with *A. Niger* where the seed weight/plant reached to 18 and 18.33 g. in both seasons and gave the highest seed yield/fad. in the first season under 31 kg P2O5/fad. with *A .Niger*. While gave the maximum seed yield /fad. (9.51 ardab/fad.) under 31 kg P2O5/fad. *A. Niger* These results revealed that the inoculation seed with fungi gave the highest values for yield and yield attributed which indicated with *A. Niger* and 31 kg P2O5/fad. Hammam, 1995 b and Aftab Afzal and Asgshari Bano , 2008,obtained similar results

Data in Table 8 . clearly showed that the differences values between cultivars were highly significant on P percentage in roots and shoots for faba bean in both seasons . Sakha 1 cultivar gave the highest values followed by Nubria 1 and Giza 843 , respectively . Data indicated that also percentage of P concentration in roots and shoots increased significantly with increasing P mineral fertilization levels from 15.5 to 31 kg P2O5 , in both seasons. In this Table the data clearly showed that the rate of 31 kg/fad. gave the highest values of P% in roots and shoots in both seasons. From that table it can notice that , the P percentage values in roots and shoots, which resulted as adding fungi, gave the highest values comparing with that received P. mineral fertilization levels . It can explain that fungi (microorganism) has ability to release soil P and P mineral fertilizers as well and increasing in sufficient rat of p, so the plants can find sufficient P. in soil solution . This data agree with that found by Mohamed, and Abbas , 2005 and Jacques, 2009 .

Table (4): Plant height and number of branches/plant as affected by faba beans cultivars, Phosphorus levels and solubilizing phosphorus fungi in 2010/2011, 2011/2012 seasons and combined analysis.

Characters	Plant height (cm)			Number of branches /plant		
Seasons	2010/11	2011/12	Com-	2010/11	2011/12	Com-
A-Cultivars:						
a1- Sakha 1	87.50	86.04	87.66	3.50	3.64	3.57
a2- Nubria 1	76.12	76.04	76.08	4.23	4.64	4.27
a3- Giza 843	97.33	99.28	98.08	3.3	3.02	3.06
F- test	*	*	*	*	*	*
L S D	0.70	0.64	0.66	1.05	0.12	0.04
B- Phosphorus levels:						
b1- 15.5 kg/fad	83.33	84.12	83.42	3.48	3.53	3.45
b2- 23.25 kg/fad	87.27	87.17	87.22	3.69	3.78	3.69
b3- 31 kg/fad.	90.25	90.08	90.17	3.87	3.98	3.90
F-test	*	*	*	*	*	*
L S D	0.83	0.80	0.62	0.03	0.13	0.04
C- Pho- soluble-fungi						
c1- Control	83.22	80.63	83.02	3.30	3.23	3.26
c2-*A. Oryza*	87.31	88.58	86.65	3.80	3.93	3.86
c3-*A. Niger*	91.65	93.88	92.70	4.15	4.30	4.23
c4-*P.purpurgenium*	85.76	85.40	85.55	3.50	3.62	3.56
F- test	*	*	*	*	*	*
L S D	0.65	1.18	0.54	0.06	0.18	0.06
D- Interaction						
d1- A x B	ns	*	*	*	ns	*
d2- A x C	*	*	*	ns	*	*
d3- B x C	*	*	*	ns	ns	ns
d4- A x B x C	*	*	*	*	ns	ns

Table (9) shows that, the interaction effect between all studied factors on P% were significant on roots and shoots in both seasons .The interaction between fungi types and phosphorus levels on P concentrations are found in Table 9. Data show the highly significant between treatments and P% under study in both seasons . It is clear that from this table A. Niger gave the highest values for P% in both seasons on roots and shoots , followed by *A. Oryza and P. purpur-* From this Table it was clearly that , adding 31 kg P2O5 with A. Niger gave the highest values , and some trend were found as adding 31 kg P2O5 other two types of fungi as well .

The reported data in Table 10 , show the interactions effect between faba bean cultivars and P% in roots and shoots in both studied seasons were highly significant . It is clear that from this Table increasing P levels from 15.5 to 31 kg P2O5 causing increasing in P percentage in roots and shoots of cultivars in both studied seasons .

Table (5): Yield and yield attributes of faba bean cultivars as affected phosphorus levels and phosphorus solubilizing fungi types in 2010/ 2011, 2011 /2012 seasons and combined anãlysis .

Characters / Seasons	n. of pods/plant			100-seed weight			Seed weight/plant			Seed yield/fad.		
	2010/11	2011/12	Comb-	2010/11	2011/12	Com-	2010/11	2011/12	Com-	2010/11	2011/12	Com-
A-Cultivars												
a1-Sakha 1	22.33	22.85	23.09	80.36	79.90	80.02	16.54	16.8/7	16.71	8.18	8.28	8.23
a2-Nubria 1	20.98	19.58	20.28	99.97	103.69	101.83	16.10	16.44	16.27	7.83	8.03	7.93
a3-Giza 843	19.50	19.75	19.63	77.11	78.64	77.89	16.48	16.78	16.63	8.05	8.25	8.15
F-test	*	*	*	*	*	*	*	*	*	*	*	*
LSD	0.54	0.25	0.24	0.37	1.63	0.41	0.08	0.11	0.07	0.05	0.03	0.04
B-P .levels												
B1-15.5 kg/f	19.66	19.42	19.54	82.61	83.79	82.62	15.89	16.00	16.01	7.74	7.89	7.82
B2-23.25kg/f	20.28	20.88	20.58	86.39	88.32	87.36	16.39	16.57	16.57	8.02	8.18	8.10
B3-31 kg/f	23.66	22.86	23.26	88.44	91.04	89.74	16.86	17.53	17.07	8.30	8.48	8.39
F-test	*	*	*	*	*	*	*	*	*	*	*	*
LSD	0.47	0.19	0.16	0.34	1.57	0.26	0.07	0.23	0.08	0.05	0.05	0.03
C-p. sol-fungi												
c1-control	17.70	19.44	18.56	80.35	83.62	82.50	15.60	16.00	15.80	7.58	7.75	7.67
c2-*A.oryza*	22.24	23.07	22.40	87.05	84.14	85.57	16.58	17.10	16.84	8.08	8.23	8.16
c3-*A.Nigar*	24.62	24.80	24.20	90.00	89.60	89.80	17.30	17.29	17.30	8.60	8.83	8.71
c4-*P.purpurge*	18.65	19.49	18.56	85.85	86.96	85.93	16.02	16.27	16.15	7.82	7.96	7.89
F-test	*	*	*	*	*	*	*	ns	*	*	*	*
L S d	0.52	0.34	0.37	0.43	1.02	0.36	0.05	-	0.12	0.08	0.06	0.05
D-interaction												
d1- A x B	ns	*	*	*	ns	*	*	ns	*	*	*	*
d2- A x c	ns	*	*	*	ns	*	*	ns	*	ns	*	*
d3- B x C	*	*	*	ns	ns	*	*	*	*	*	*	*
d4-A xB x C	ns	*	*	ns	ns	*	*	*	*	*	*	*

Table (6): Seed weight (g.)/plant and seed yield (ardab/fad.) as affected by the interaction faba bean cultivars and phosphours levels in 2010/2011 and 2011/2012 seasons.

Characters / Seasons	Seed weight (g)						Seed yield (ardab/fad.)					
	2010/2011			2011/2012			2010/2011			2011/2012		
P. levels	15.5 kg	23.25 kg	31 kg	15.5 kg	23.25 kg	31 kg	15.5 kg	23.25 kg	31 kg	15.5 kg	23.25 kg	31 kg
Cultivars												
Sakha 1	16.12	16.58	16.94	16.43	16.98	17.19	7.83	8.08	8.26	8.01	8.25	8.49
Nubria 1	15.65	16.03	16.57	15.95	16.45	16.93	7.57	7.76	8.13	7.74	8.00	8.34
Giza 843	15.83	16.54	17.03	16.09	16.88	17.37	7.83	8.19	8.52	7.93	8.29	8.62
F- test	*			*			*			*		
LSD	0.12			0.15			0.10			0.11		

Table (7): Seed weight/plant and seed yield/fad. as affected by the interaction between faba bean cultivars, phosphours levels and phosphours solubilizaing fungi in 2010/2011and 2011/2012 seasons .

Characters / Seasons / P. Sol. Bacteria		Seed weight (g.) /plant								Seed yield (ardab/fad.)							
		2010/2011				2011/2012				2010/2011				2011/2012			
		Con-	Ao	An	Pp	Con-	Ao	An	Pp	Con-	Ao	An	Pp	Con-	Ao	An	Pp
Cultivars	P. levels																
	15.5 kg	15.57	16.23	17.00	15.65	16.13	16.73	16.90	15.93	7.39	7.97	8.21	7.73	7.70	8.03	8.44	7.15
Sakha1	23.25kg	15.90	16.73	17.47	16.20	16.55	17.17	17.57	16.20	7.67	8.12	8.57	7.93	7.86	8.26	8.70	7.87
	31 kg	16.30	17.10	17.60	16.77	17.00	17.70	17.87	16.67	7.73	8.17	9.19	7.95	7.87	8.26	9.85	7.99
	15.5 kg	14.90	15.77	16.53	15.40	15.52	16.32	16.37	15.53	7.25	7.59	8.02	7.40	7.44	7.78	8.24	7.51
Nubria 1	23.25kg	15.23	16.13	17.10	15.77	16.10	16.73	16.90	16.07	7.45	7.91	8.15	7.60	7.66	8.10	8.44	7.81
	31 kg	15.93	17.07	17.40	16.07	16.53	17.40	17.63	16.17	7.64	8.07	8.91	7.91	7.81	8.46	9.05	8.03
	15.5 kg	15.33	16.07	16.33	15.60	15.90	16.27	16.47	15.73	7.49	7.93	8.61	7.72	7.59	8.03	8.26	7.82
Giza 843	2325 kg	15.27	17.00	17.90	16.10	16.03	17.60	17.57	16.30	7.68	8.34	8.76	7.98	7.78	8.44	8.86	8.08
	31 kg	15.93	17.10	18.33	17.73	16.60	18.00	18.33	16.53	7.94	8.59	9.41	8.15	8.03	8.69	9.51	8.25
	F-test	*							*	*						*	
	LSD	0.11							0.15	0.12						0.13	

Table (8): Phosphorus percentage in root and shoot of faba bean cultivars as affected by P. Levels and solubilizing phosphorus fungi during 2010/2011 and 2011/2012 seasons.

Seasons	2010/2011		2011/2012	
Characters	Roots	Shoots	Roots	Shoots
A- cultivars :				
A1- Sakha 1	0.0159	0.0204	0.0161	0.0206
A2- Nubria 1	0.0130	0.0190	0.0151	0.0192
A3- Giza 843	0.0150	0.0198	0.0151	0.0200
F- test	**	**	**	**
L S D	0.0004	0.0005	0.0005	0.0006
B- P. Levels :				
B1- 15.5 kg P2O5/fad.	0.0127	0.0181	0.0134	0.0178
B2- 23.25kg P2O5/fad.	0.0132	0.0193	0.0144	0.0198
B3- 31 kgP2O5/fad.	0.0174	0.0218	0.0185	0.0216
F- test	*	*	*	*
L S D	0.0004	0.0005	0.0004	0.0006
C- Solubilizing P. Fungi				
C1- Control	0.0039	0.0064	0.0040	0.0065
C2- A. Oryza	0.0179	0.0236	0.0187	0.0237
C3- A. Niger	0.0205	0.0263	0.0217	0.0270
C4- P. purpurgenium	0.0168	0.0222	0.0173	0.0225
F- test	**	**	**	**
L S D	0.0005	0.0006	0.0005	0.0007
D- Interactions :				
D1- A x B	*	*	*	*
D2- A x C	*	*	*	*
D3- B x C	*	*	*	*
D4- A x B x C	*	*	*	*

Table (9): Effect the interaction between phosphorus levels and fungi types on phosphorus percentage in Roots and Shoots during 2010/2011 and 2011/2012 seasons.

Seaons	2010/2011						2011/2012					
Characters	Roots			Shoots			Roots			Shoots		
P. Levels kg	15.5	23.25	31	15.5	23.25	31	15.5	23.25	31	15.5	23.25	31
Fungi types												
Control	0.0030	0.0037	0.0048	0.0047	0.0060	0.0086	0.0047	0.0060	0.0085	0.0030	0.0037	0.0053
A. Oryza	0.0154	0.0167	0.0213	0.0217	0.0232	0.0257	0.0218	0.0232	0.0257	0.0169	0.0174	0.0223
A. Niger	0.0185	0.0189	0.0145	0.0243	0.0272	0.0288	0.0243	0.0273	0.0288	0.0195	0.0200	0.0257
P. Purpur-	0.0136	0.0157	0.0196	0.0205	0.0228	0.0233	0.0205	0.0228	0.0233	0.0147	0.0166	0.0206
F-test	*	*	*	*	*	*	*	*	*	*	*	*
L S D	0.0026			0.0044			0.0033			0.0044		

The reported data in Table 10 , show the interactions effect between faba bean cultivars and phosphorus level on P % in roots and shoots , it is clear that increasing P levels from 15.5 to 31 kg P2O5 caused increasing in P. percentages in roots and shoots of faba bean cultivars in both seasons .

Table (10): Effect the interaction between faba bean cultivars and phosphorus levels on P percentage in roots and shoots during 2010/2011 and 2011/2012 seasons.

Season	2010/2011					
Cultivars	Sakha 1		Nubria 1		Giza 843	
characters	Roots	Shoots	Roots	Shoots	Roots	Shoots
P. Levels						
15.5kg	0.0131	0.0182	0.0121	0.0174	0.0127	0.0178
23.25kg	0.0149	0.0201	0.0123	0.0193	0.0141	0.0200
31 kg	0.0197	0.0229	0.0147	0.0202	0.0183	0.0217
F- test	*	*	*	*	*	*
L S D	0.0009					0.0018
Season	2011/2012					
Cultivars	Sakha 1		Nubria 1		Giza 843	
characters	Roots	Shoots	Roots	Shoots	Roots	Shoots
P. Levels						
15.5 kg	0.0140	0.0182	0.0128	0.0174	0.0135	0.0178
23.25 kg	0.0155	0.0201	0.0129	0.0193	0.0148	0.0200
31 kg	0.0207	0.0300	0.0156	0.0202	0.0191	0.0217
F- test	*	*	*	*	*	*
L S D	0.0015					0.0018

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استجابة بعض أصناف من الفول البلدي للتسميد بمستويات مختلفة من الفسفور مع الفطريات المذيبة للفوسفور.

السيد الغزالي عباس* ، محمد مجدي المتولي** و محمد رضا عبد الهادي محمد ***

* معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية– الجيزة – مصر

** قسم النبات – كلية العلوم– جامعة دمنهور– مصر

*** معهد بحوث الأراضي والمياه والبيئة –مركز البحوث الزراعية – مصر

تم تنفيذ تجربتان حقليتان في محطة البحوث الزراعية بتاج العز– محافظة الدقهلية– جمهورية مصر العربية خلال موسمي الزراعة ٢٠١٠/٢٠١١ و ٢٠١١/٢٠١٢ لدراسة تأثير التسميد بثلاثة معدلات مختلفة من السوبر فوسفات (١٥,٥، ٢٣,٢٥و ٣١ كجم فو٢أ٥/ فدان) مع ثلاثة أنواع من الفطريات المذيبة للفوسفور(أسبرجلس أوريزا ، أسبرجلس نيجر ، بنسليوم بروبروبجنيم)لتحسين المحصول و مكوناته لثلاثة أصناف من الفول البلدي (سخا ١ ، نوبارية ١ وجيزة ٨٤٣). أوضحت النتائج الآتي :-

١- أشارت النتائج التي تم التوصل إليها في هذه الدراسة إلى وجود فروق معنوية بين الأصناف المستخدمة في هذه الدراسة في كل الصفات التي تم دراستها خلال موسمي الزراعة والتحليل المشترك بين الموسمين حيث تفوق الصنف سخا ١ في صفة وزن الجذور و وزن العقد الجذرية التي تم حسابها بعد ٤٥و ٦٠ يوم من الزراعة أعطى أعلى القيم لصفات عدد

القرون ، وزن البذور/نبات و محصول البذور للفدان مقارنة بالأصناف الأخرى . وسجل الصنف نوبارية ١ أعلى قيم لصفة عدد الأفرع/نبات و وزن-١٠٠ بذرة مقارنة بالصنف سخا ١ وجيزة ٨٤٣ الذي تفوق في صفة طول النبات فقط .

٢- زيادة التسميد بالسوبر فوسفات من ١٥,٥ إلى ٣١ كجم فو٢أ٥/فدان أدى إلى زيادة معنوية لكل مكونات المحصول والذي أدى بالتالي لزيادة المحصول للفدان حيث وصل إنتاج الفدان إلى ٨,٣٠ ، ٨,٤٨ و إردب ٨,٣٩ مقابل ٧,٧٤ ، ٧,٨٩ و ٧,٨ أرد ب/فدان للمستوى ١٥,٥ كجم/فدان و ٨,٠٢ ، ٨,١٨ و ٨,١٠ إردب للفدان للمستوى ٢٣,٢٥كجم فو٢أ٥/ف في موسمي الزراعة والتحليل المشترك .

٣- أدى تلقيح البذور بالفطريات المذيبة للفسفور لوجود فروق معنوية للصفات المدروسة مقارن بالمعاملات التي لم تلقح كما وجدت فروق معنوية فيما بين أنواع الفطريات على أصناف الفول البلدي مقارنة بالأصناف الأخرى . تلقيح البذور بالأسبرجلس نيجر أعطى اختلافات معنوية لكل الصفات المدروسة حيث وصل إنتاج الفدان من البذور إلى ٨,٦٠ ، ٨,٨٢ و ٨,٧١ إردب للفدان مقارنة ب ٨,٠٨ ، ٨,٢٣ و ٨,١٦ إردب للفدان مع أسبر جلس أوريزا ، ٧,٨٢ ، ٧,٩٥ و ٧,٨٩ مع بنسليوم بروبروجنيم و ٧,٥٨ ، ٧,٧٥ و ٧,٦٧ إردب للفدان مع معاملة الكنترول في موسمي الزراعة والتحليل المشترك على التوالي .

٤- التفاعل المشترك بين أصناف الفول البلدي ومستويات الفسفور أظهر فروق معنوية لوزن العقد الجذرية عند ٤٥ و ٦٠ يوم للصنف سخا ١ مع المستوى ٣١ كجم فو٢أ٥/فدان ، كما كانت الفروق معنوية أيضا لوزن بذور النبات و محصول البذور للفدان لنفس المستوى مع الصنف جيزة ٨٤٣ مقارنة لمستويات الفسفور المختلفة مع الأصناف الأخرى في كلا موسمي الزراعة . من ناحية أخرى كان للتفاعل الثلاثي بين الأصناف ، مستويات الفسفور المختلفة والفطريات المذيبة للفوسفور أثر عالي لوجود فروق معنوية عالية لصفتي وزن بذور النبات ومحصول البذور للفدان فقد أعطى الصنف سخا ١ أعلى قيم لها تان الصفتان تحت المستوى ٣١ كجم فو٢أ٥ /للفدان مع التلقيح بلأسبرجلس نيجر مقارنة مع الأصناف الأخرى تحت مستويات الفسفور المختلفة والتلقيح بالأنواع البكتيرية الأخرى.

٥-وقد أشارت النتائج في جداول تحليل نسبة الفوسفور في كل من الجذور والمجموع الخضري إلى وجود فروق معنوية للنسبة المئوية للفسفور في الصنف سخا١ نتيجة التسميد بالسوبر فوسفات بمعدل ٣١كجم فو٢٥ مع التلقيح بالأسبرجلس نيجر مقارن بالأصناف الأخرى مع المعدلات الأخرى من الفوسفور والتلقيح بالفطريات الأخرى .

قام بتحكيم البحث

أ.د / محمد وجدى العجرودى — **كلية الزراعة – جامعة المنصورة**

أ.د / احمد حلمى عبد اللطيف حسين — **مركز البحوث الزراعية**