Future of Egyptian Cotton Production in the Newly Reclaimed Desert Land of Egypt. 8- Response of Cotton to Inoculation with Phosphate-Solubilizing Bacteria and Soil Phosphorus Application

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ABSTRACT

This is the eighth part in a series of studies aiming at helping the cotton growers in the desert regions. Two field experiments were conducted on highly calcareous sandy clay loam soil at Nubaria Agric. Res. Stn. during 1999 and 2000 seasons to study the response of extra-long satple cotton cultivar Giza 70 to inoculation with a phosphate- solubilizing bacteria (PSB), i.e., "Phosphorin" as Egyptian commercial biofertilizer compared to non-inoculation treatment on some plant growth attributes, earliness parameters, seed cotton yield/fed, its components, fiber properties and net income values/fed under the three levels of phosphorus (P) fertilizers (7.5, 15 and 22.5 kg P_2O_5/fed). The results indicated that application of 22.5 kg P_2O_5/fed significantly increased earliness parameters, number of open bolls/plant, seed cotton yield/plant, seed cotton yield/fed, total costs/fed, income/fed, consequently net income/fed in the two seasons. While, P fertilizer levels had insignificant effects on boll weight, lint percentage in one season only, plant height, number of sympodia/plant, number of plants/fed at harvest and fiber properties in the two seasons. Application of "Phosphorin" biofertilizer significantly increased plant height, number of sympodia/plant, earliness parameters, seed cotton yield/fed, its components, net income and its components compared with non-inoculation treatment in both 1999 and 2000 seasons. On the other hand, biofertilizer treatments had insignificant effect on number of plants/fed at harvest, lint percentage and fiber properties in the two seasons. The interaction effects between the levels of P fertilization and biofertilizer treatments were also evaluated. Hence, it might be concluded that the highest yield of seed cotton/fed (6.39, 5.60 kentar), consequently net income/fed (2009, 1376 L.E.) in 1999 and 2000 seasons, respectively, under the newly reclaimed desert land of West Nubaria region, were obtained by inoculation of cotton seeds with "Phosphorin" biofertilizer under the high level of P fertilization (22.5 kg P_2O_5/fed) compared with the other studied treatments and this treatment is promising in growing cotton crop on calcareous soil.

INTRODUCTION

The use of phosphate-solubilizing bacteria (PSB) became necessary to minimize the use of large doses of chemical P fertilizers which cause environmental pollution. In this respect, Koreish *et al.* (1998) reported that PSB is recommended to decrease the mineral P fertilizer dose to 20 units/fed with inoculation by PSB. The low availability of P and micronutrients to plant common in highly calcareous soil with basic soil pH. Therefore, the ability of rhizosphere bacteria to solubilize phosphorus may be important in the newly reclaimed desert land of Egypt, where soil available P is low. Several workers reported that the application of PSB increases the efficiency of phosphoric fertilizers through solubilizing the fixed by acids produced from bacteria (Gaur *et al.*, 1980, Gaur, 1985, Laheurte and Barthelin, 1988; Gaind and Gaur, 1991; El-Sayed, 1999 and Koreish *et al.*, 2001). In the present day, biofertilization

becomes an important factor to increase the availability of P and micronutrients to correct their defficiencies in calcareous soils. Some studies have reported that PSB can solubilize P and enhance its absorption by plant roots (Azcon *et al.*, 1976; El-Attar *et al.*, 1979; Fawaz *et al.*, 1980, Battisha, 1998; El-Sayed, 1999 and Koreish *et al.*, 2001). They found also that increased yield response of crop plants have been observed following seed inoculation with PSB.

Information available on P requirements of cotton plants showed better response to moderate rate of P application, i.e., 15-30 kg P_2O_5/fed (Hamissa *et al.*, 1980; Ali *et al.*, 1986; Hosny *et al.*, 1989; Abdel-Aal *et al.*, 1990; Ali *et al.*, 1996; El-Nagar *et al.*, 1996 and Battisha, 1998).

The objective of the present study was to examine the effect of two biofertilizer treatments under three P fertilizer levels and their interactions on seed cotton yield, its components, fiber properties and net income in the newly reclaimed desert land of West Nubaria region.

MATERIALS AND METHODS

Two field experiments were carried out on highly calcareous sandy clay loam soil, classified as a calciorthids typical of Northern Tahrir at Nubaria Agricultural Research Station, during the two successive seasons of 1999 and 2000. Cotton growth, yield, fiber properties and net income were evaluated under two factors : bio-and mineral-phosphorus fertilization. The experimental design was split-plot with four replicates. Three phosphorus fertilizer levels, namely 7.5, 15.0 and 22.5 kg P_2O_5/feddan were added within planting in the form of calcium superphosphate (15.5% P_2O_5). The P fertilizer levels were assigned to the main plots, each of which was divided into two sub-plots for testing "Phosphorin" biofertilizer vs. non-inoculation treatment. The sub-plot size was 18.75 m^2, which accommodated five ridges, each 5 m long, 0.75 m apart and the distance between hills was 20 cm. Cotton seeds of Giza 70 extra-long staple cultivar were planted on 3 and 10 April after Egyptian clover in 1999 and 2000 seasons, respectively. Before the first irrigation, the plants were thinned to two plants/hill. Average yearly fertilizer rates for cotton were 75 kg N/fed and 48 kg K_2O/fed as ammonium sulphate (20.5% N) and potassium sulphate (48% K_2O), respectively. Nitrogen was side dressed one, half of it before the first irrigation and the other half before the second irrigation. All potassium fertilizer was added with the second dose of N fertilizer. Soil analysis before planting were determined and recorded in Table (1) according to the method described in Page *et al.* (1982). The biofertilizer "Phosphorin" is a phosphate-solubilizing bacteria (PSB) *Bacillus megaterium*. Such product is produced by the General Organization for Agricultural Equalization Fund, Ministry of Agriculture, Egypt (Abou El-Naga, 1993). The inoculation was performed by coating cotton seeds at the rate of 0.90 kg/fed using a sticking substance (Arabic gum 5%) just before sowing. The standard commercial

management practices for the region were followed.

At harvesting, ten random guarded plants were taken from each sub-plot to determine final plant height, number of sympodia/plant, first sympodial position, days from sowing to the first flower appearance as well as to first open-boll, earliness percentage, number of open-bolls/plant, boll weight, seed cotton yield/plant, fiber length at 2.5% span length, fiber strength (g/tex), fiber fineness (micronaire reading) and net income/fed according to Hamissa *et al.* (2000). The number of plants/fed at harvest also was determined. Seed cotton yield was calculated from the three inner ridges in each sub-plot and was converted into kentar/fed (157.5 kg/4200 m^2).The agronomic data of the two seasons were statistically analyzed at 0.05 probability level for a split plot design according to SAS-GLM procedure outlined by (SAS, 1988).

Table 1. Soil chemical and physical properties of the experimental site in 1999 and 2000 seasons.

Characters	Mean value	
	1999	2000
EC, dS/m (soil paste ext.)	1.47	1.52
pH (1 : 2.5)	8.40	8.45
CaCO3 (%)	23.85	24.05
Organic matter (%)	0.51	0.49
NH_4 OAC ext.K (mg/kg soil)	205.00	201.18
$NaHCO_3$ ext.P (mg/kg soil)	4.56	4.47
Total N (%)	0.11	0.13
Particle size distribution (%) :		
Sand	47	48
Silt	29	28
Clay	24	24
Soil texture	Sandy clay loam	

RESULTS AND DISCUSSION

1. Main effect :

1.1. Phosphorus fertilizer level effect :

1.1.1. Growth attributes and earliness parameters :

Results in Table (2) show that increasing the level of P fertilization from 7.5 to 22.5 kg P_2O_5/fed insignificantly increased plant height and number of sympodia/plant in both 1999 and 2000 seasons. Similar results were obtained by Abdel-Aal *et al.*, 1996 and El-Nagar *et al.*, 1996. They found that added P had no significant effect on either plant height or number of the sympodia/plant, in general increment of P level in the soil caused a decrement in final plant height and number of sympodia/plant. Increasing the level of P

fertilization significantly decreased first sympodial position, days from sowing to first flower appearance as well as to first open boll in both seasons (Table 2). The response of cotton plants to reducing the first sympodial position, days to first flower appearance as well as to first open boll by increasing P levels may be due to the role of P for encouraging the lower sympodium to grow early and encourage the flowering and setting hormonies to be formed early which reflect on production of earlier maturity of cotton plants. But earliness percentage was significantly increased as P levels increased in the two seasons (Table 2). These results may be due to the reducing position of first sympodium and early of both flowering and setting. These results were agreement with Silva *et al.*, 1990; Ali *et al.*, 1996 and Battisha *et al.*, 1998.

1.1.2. Seed cotton yield/fed and its components :

The results record in Table (3) show that P levels had significant effect on boll weight in the first season only, number of open bolls/plant, seed cotton yield/plant and seed cotton yield/fed in favour of the highest level of P, i.e., 22.5 P_2O_5/fed in both seasons. The increase in seed cotton yield/plant was not only due to the increase of number of open bolls/plant, but also due to the increase of boll weight by increasing P levels, which was reflected on seed cotton yield/fed (Table 3). The highest level of 22.5 kg P_2O_5/fed gave the largest numbers of open bolls/plant (8.21, 6.44), the heaviest boll weights (2.25, 2.31 g) and the highest yields of seed cotton/plant (18.50, 14.82 g), consequently the highest yields of seed cotton/fed (6.39, 5.11 kentar) compared to the two lower P fertilization levels in 1999 and 2000 seasons, respectively (Table 3). The significant increases in seed cotton yield/fed and its components due to increasing P fertilization level could be explained on the role of P fertilization in decreasing in values of the bulk density and increasing in total porosity, hydraulic conductivity and infiltration rate of the soil. Moreover, available P cation exchange capacity increased (El-Nagar *et al.*, 1996). These results are in accordance with findings of Silva *et al.*, 1990; Ragab *et al.*, 1991, El-Debaby *et al.*, 1995; Ali *et al.*, 1996; El-Nagar *et al.*, 1996, Battisha, 1998 and El-Haddad *et al.*, 2001. Table (3) also shows that P fertilization levels did not exhibit any significant effect on number of plants/fed at harvest in both 1999 and 2000 seasons. Th result was expected since the same planting method and management practices were followed for all P fertilization levels.

1.1.3. Lint percentage and fiber properties :

Data in Table (4) show that increasing the level of P fertilization from 7.5 to 22.5 kg P_2O_5/fed significantly increased lint percentage in the first season only. While fiber properties were not affected by the three P fertilization levels in the two seasons (Table 4). This may be attributed to the realization that these characteristics were less affected by the environmental factors. Similar results were obtained by Ragab *et al.*, 1991; El-Debaby *et al.*, 1995 and Battisha, 1998. They found that fiber properties were not generally significantly affected by the levels of P fertilization.

Table 2. Means of growth attributes and earliness parameters as affected by phosphorus levels and phosphorin during 1999 and 2000 seasons.

Treatments	Plant height (cm)		No. of sympodia/plant		First sympodial position		Days to first flower appearance		Days to first open boll		Earliness percentage (%)	
	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000
Phosphorus levels (P):												
7.5 kg P_2O_5/fed	124.64	124.98	13.94	14.14	6.81 a	6.91 a	78.76 a	79.23 a	136.03 a	136.44 a	73.89 c	52.20 c
15.0 kg P_2O_5/fed	124.90	125.20	14.33	14.59	6.85 b	6.40 b	76.86 b	78.66 b	131.71 b	134.48 a	76.12 b	56.19 b
22.5 kg P_2O_5/fed	126.18	125.86	14.48	14.66	6.70 b	6.79 c	74.98 c	75.73 c	129.60 b	129.96 b	78.43 a	60.09 a
L.S.D. (0.05)	N.S.	N.S.	N.S.	N.S.	0.51	0.31	1.34	1.19	2.13	1.97	1.54	3.23
Biofertilizer (B) :												
Non-inoculation	123.68	124.84	13.88	14.15	6.41	6.73	77.84	78.76	133.26	134.08	74.63	54.90
Phosphorin	126.79	125.85	14.61	14.78	6.93	6.00	75.88	76.99	130.97	132.51	77.66	57.41
L.S.D. (0.05)	0.77	0.86	0.25	0.23	0.46	0.30	1.11	0.65	2.07	1.27	1.75	2.14
Grand mean	125.24	125.35	14.25	14.46	6.12	6.37	76.86	77.87	132.11	133.30	76.14	56.16
P x B	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	***	N.S.	*	N.S.	N.S.

*, ** and *** refer to 0.05, 0.01 and 0.001 level of significance.
N.S. = Not significant.

Table 3. Means of seed cotton yield, yield components and number of plants/fed as affected by phosphorus levels and phosphorin during 1999 and 2000 seasons.

Treatments	No. of open bolls/plant		Boll weight (g)		Seed cotton yield/plant (g)		No. of plants/fed		Seed cotton yield/fed (kentar)	
	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000
Phosphorus levels (P):										
7.5 kg P_2O_5/fed	7.38 c	5.31 c	2.04 c	2.24	15.10 c	11.93 c	54073	53466	5.18 c	4.32 c
15.0 kg P_2O_5/fed	7.85 b	6.00 b	2.19 b	2.27	17.25 b	13.60 b	54146	53616	5.95 b	4.81 b
22.5 kg P_2O_5/fed	8.21 a	6.44 a	2.25 a	2.31	18.50 a	14.82 a	54438	53616	6.39 a	5.11a
L.S.D. (0.05)	0.08	0.40	0.03	N.S.	0.15	1.05	N.S.	N.S.	0.06	0.14
Biofertilizer (B) :										
Non-inoculation	7.54	5.55	2.14	2.26	16.17	12.54	54122	53599	5.49	4.46
Phosphorin	8.10	6.27	2.18	2.29	17.72	14.36	54316	53533	6.20	5.03
L.S.D. (0.05)	0.11	0.15	0.02	0.02	0.18	0.61	N.S.	N.S.	0.06	0.16
Grand mean	7.82	5.91	2.16	2.27	16.95	13.45	54219	53566	5.84	4.75
P x B	***	***	*	N.S.	***	**	N.S.	N.S.	***	***

*, ** and *** refer to 0.05, 0.01 and 0.001 level of significance.
N.S. = Not significant.

Table 4. Means of lint percentage and fiber properties as affected by phosphorus levels and phosphorin during 1999 and 2000 seasons.

Treatments	Lint percentage (%)		Fiber length at 2.5% S.L. (mm)		Fiber strength (g/tex)		Micronaire reading	
	1999	2000	1999	2000	1999	2000	1999	2000
Phosphorus levels (P):								
7.5 kg P_2O_5/fed	37.51 b	38.17	33.09	33.16	34.36	34.46	3.69	3.89
15.0 kg P_2O_5/fed	38.10 ab	38.14	33.13	33.20	34.41	34.49	3.74	3.95
22.5 kg P_2O_5/fed	38.21 a	38.17	33.14	33.23	34.48	34.54	3.79	4.00
L.S.D. (0.05)	0.68	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Biofertilizer (B) :								
Non-inoculation	37.95	38.16	33.10	33.18	34.40	34.48	3.73	3.93
Phosphorin	37.93	38.16	33.13	33.22	34.43	34.51	3.76	3.97
L.S.D. (0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Grand mean	37.94	38.16	33.12	33.20	34.42	34.50	3.74	3.95

All the first-order interactions, P x B, were not significant.

1.2. Biofertilizer effect :

1.2.1. Growth attributes and earliness parameters :

All the studied plant growth attributes and earliness parameters, in Table (2), were significantly affected by PSB in both 1999 and 2000 seasons. The highest mean values of plant heights (126.79, 125.85 cm), numbers of sympodia/plant (14.61, 14.78) and earliness percentages (77.65, 57.41%) were obtained when cotton seeds were inoculated with the Egyptian commercial biofertilizer "Phosphorin" compared to non-inoculation treatment in both seasons, respectively (Table 2). This behaviour was accompanied with decreasing positions of the first sympodium (5.83, 6.00), days to first flower appearance (75.88, 76.99 day) and days to first boll opening (130.97, 132.51 day) when cotton seeds were inoculated with "Phosphorin" compared to non-inoculation treatment in 1999 and 2000 seasons, respectively. In this respect, Battisha (1998) reported that plant height and number of sympodia/plant were increased and days to first flower appearance was decreased when cotton seeds were inoculated with "Phosphorin" compared to non-inoculation treatment. Also, Kucey (1988) found that increasing growth attributes and earliness percentage due to inoculation with PSB were attributed to the reduction of media pH and hence the solubility of phosphates.

1.2.2. Seed cotton yield/fed and its components :

"Phosphorin" biofertilizer addition gave significant effects on seed cotton yield/fed and its components, while number of plants/fed was not affected by this addition in 1999 and 2000 seasons (Table 3). Number of open bolls/plant, boll weight, consequently seed cotton yield/plant tended to increase when cotton seeds were inoculated with "Phosphorin" biofertilizer compared with the non-inoculation treatment (Table 3). It is obvious that the largest numbers of open bolls/plant (8.10, 6.27), the heaviest boll weights (2.18, 2.29 g), consequently the highest yields of seed cotton/plant (17.72, 14.36 g) were produced with cotton seed inoculation by "Phosphorin" biofertilizer compared to the non-inoculation treatment in 1999 and 2000 seasons, respectively (Table 3). The previous results explained the highest yields of seed cotton/fed (6.20, 5.03 kentar) in favour of "Phosphorin" biofertilizer compared with the non-inoculation treatment in the two seasons, respectively.

1.2.3. Lint percentage and fiber properties :

Data in Table (4) show that lint percentage and fiber properties were not affected by biofertilizer treatments in the two seasons. In this respect, Battisha (1998) found that "Phosphorin" biofertilizer addition gave significant effect on lint percentage, but no significant differences were obtained in fiber properties due to this addition.

1.3. Net income/fed :

Results in Table (5) show that net income/fed increased by increasing P fertilizer level in both seasons. The highest net income values/fed (1772, 1158 L.E.) were obtained from the high P level of 22.5 kg P_2O_5/fed, while the lowest one (1263, 835 L.E.) were obtained from the low P level of 7.5 kg P_2O_5/fed in 1999 and 2000 seasons, respectively.

With regard to biofertilizer effect, Table (5) also shows that the highest net income values/fed (1698, 1137 L.E.) were obtained from the commercial biofertilizer "Phosphorin" application compared with non-inoculation treatment (1387, 885 L.E.) in the two seasons, respectively.

The significant increases in net income/fed due to high P fertilization and/or "Phosphorin" biofertilizer treatment could be explained on the role of these treatments in increasing seed cotton yield/fed which increased income/fed (Tables 3 and 5).

2. The interaction effects :

Regarding the interaction between P fertilizer levels (P) and biofertilizer treatments (B), it had insignificant effects on days from sowing to first flower appearance as well as to first open boll, boll weight in one season only. While, plant height, number of sympodia/plant, first sympodial position, earliness percentage, number of plants/fed, lint percentage, fiber properties and total costs/fed were insignificantly affected by the two-factor interaction, P x B, in both seasons (Tables 2,3,4 and 5). The insignificant P x B interaction for these traits indicating that the independent effect for these two factors on these characteristics. In other words, the response to P fertilization level was similar at each biofertilizer treatment.

On the other hand, number of open bolls/plant, seed cotton yield per plant as well as per fed, income/fed and consequently net income/fed were significantly affected by the first-order interaction, P x B, in the two seasons (Tables 3 and 5). The data given in Table (6) show that inoculation of cotton seeds with "Phosphorin" biofertilizer when conjugated with the high P rate (22.5 P_2O_5/fed) produced the highest values for seed cotton yield/plant and the two main yield components, i.e., number of open bolls/plant and boll weight in the two seasons. From Table (7) it can be noticed that the highest yields of seed cotton/fed (6.93 and 5.60 kentar) resulted from the combination between the high P level (22.5 P_2O_5/fed)and biofertilization. It is evident also that applying 7.5, 15 and 22.5 kg P_2O_5/fed with the commercial biofertilizer "Phosphorin" increased seed cotton yield/fed by 6.99, 12.30 and 18.26% in the first season and 6.21, 10.50 and 21.21% in the second season compared to applying these three P fertilization levels alone, respectively (Table 7). The positive effect of using "Phosphorin" with the three P fertilization levels compared to their use alone may by due to that "Phosphorin" biofertilizer consists of phosphate solubilizing bacteria (PSB) and these microorganisms release much more P, leading to create a balance between N and P and hence increase plant growth

Table 5. Means of net income/fed and its components as affected by phosphorus fertilizer levels and biofertilizer treatments during 1999 and 2000 seasons.

Treatments	Total costs/fed** (L.E.)		Income/fed (L.E.)		Net income/fed (L.E.)	
	1999	2000	1999	2000	1999	2000
Phosphorus levels (P):						
7.5 kg P_2O_5/fed	1056 c	1111 c	2319 c	1946 c	1263 c	835 c
15.0 kg P_2O_5/fed	1071 b	1127 b	2664 b	2166 b	1593 b	1039 b
22.5 kg P_2O_5/fed	1088 a	1143 a	2861 a	2302 a	1772 a	1158 a
L.S.D. (0.05)	2.71	1.86	27.36	60.80	28.48	60.12
Biofertilizer (B) :						
Non-inoculation	1069	1124	2456	2009	1387	885
Phosphorin	1075	1130	2773	2267	1698	1137
L.S.D. (0.05)	1.43	1.41	27.81	70.82	28.52	70.91
Grand mean	1072	1127	2615	2138	1543	1011
P x B	N.S.	N.S.	***	**	***	**

* Price of biofertilizer used = 6 L.E./fed.
* Prices of 7.5, 15 and 22.5 kg P_2O_5/fed = 16,32 and 48 L.E.., respectively.
* Prices of seed cotton yield (kentar) = 447.38 and 450.18 L.E. for Giza 70 cultivar in 1999 and 2000 seasons, respectively.
** According to Abou-Zaid, 1999.

Table 6. Means of seed cotton yield/plant and yield components as affected by the first-order interaction, P x B, during 1999 and 2000 seasons.

Character	Season	Biofertilizer (B)	P_2O_5 kg/fed (P)			L.S.D. (0.05)
			7.5	15	22.5	
No. of open bolls/plant	1999	Non-inc.[1]	7.28 e	7.58 cd	7.75 c	0.18
		Phorn.[2]	7.48 d	8.13 b	8.68 a	
	2000	Non-inc.	5.18 e	5.73 c	5.80 c	0.25
		Phorn.	5.45 d	6.28 b	7.08 a	
Bool weight (g)	1999	Non-inc.	2.03 e	2.18 c	2.22 b	0.02
		Phorn.	2.06 d	2.21 b	2.28 a	
	2000	Non-inc.	2.23	2.26	2.29	N.S.
		Phorn.	2.25	2.29	2.32	
Seed cotton yield/plant (g)	1999	Non-inc.	14.79 f	16.52 d	17.21 c	0.31
		Phorn.	15.41 e	17.97 b	19.79 a	
	2000	Non-inc.	11.58 d	12.92 c	13.12 c	1.06
		Phorn.	12.28 cd	14.28 b	16.52 a	

1- Non-inoculation treatment.
2- Phosphorin biofertilizer at the rate of 0.90 kg/fed.

Table 7. Means of seed cotton yield/fed, income and net income/fed as affected by the first-order interaction, P x B, during 1999 and 2000 seasons.

Character	Season	Biofertilizer (B)	P_2O_5 kg/fed (P)			L.S.D. (0.05)
			7.5	15	22.5	
Seed cotton yield/fed (kentar)	1999	Non-inc.[1]	5.01 f	5.61 d	5.86 c	0.11
		Phorn.[2]	5.36 e	6.30 b	6.93 a	
	2000	Non-inc.	4.19 d	4.57 c	4.62 c	0.27
		Phorn.	4.45 cd	5.05 b	5.60 a	
Income/fed (L.E.)	1999	Non-inc.	2240 f	2508 d	2621 c	48.17
		Phorn.	2398 e	2820 b	3100 a	
	2000	Non-inc.	1888 d	2058 c	2081 c	122.66
		Phorn.	2004 cd	2274 b	2523 a	
Net income/ fed (L.E.)	1999	Non-inc.	1187 f	1440 d	1535 c	49.40
		Phorn.	1339 e	1746 b	2009 a	
	2000	Non-inc.	779 d	934 c	941 c	122.82
		Phorn.	891 cd	1145 b	1376 a	

1- Non-inoculation treatment.
2- Phosphorin biofertilizer at the rate of 0.90 kg/fed.

attributes, earliness parameters (Table 2) and consequently seed cottonyield/fed and its components (Table 3). In this concern, Mahmoud and Abd El-Hafez (1982) found that after fertilization with superphosphate, the level of available phosphorus decreases sharply after a short period from application in alkaline soil. Also, Ibrahim *et al.* (1986) reported that plants absorb more phosphorus in the presence of phosphate solubilizing microorganisms. The same trend was obtained for the P x B interaction effect on income/fed and net income/fed in the two seasons (Table 7), where the highest net income values/fed (2009, 1376 L.E.) in 1999 and 2000 seasons, respectively, were obtained from inoculation of cotton seeds with "Phosphorin" biofertilizer when conjugated with the high P rate (22.5 kg P_2O_5/fed). But the difference in net income/fed between the two high levels of P fertilization, i.e., 15 and 22.5 kg P_2O_5/fed, under non-inoculation treatment was not significant in the second season (Table 7). This result may be due to no significant differences were obtained in seed cotton yield/fed and its components, consequently income/fed due to the two high P levels under non-inoculation treatment in the same season (Tables 6 and 7).

As a conclusion of the above results, it's advisable to inoculate cotton seeds with "Phosphorin" biofertilizer when conjugated with using the high P rate (22.5 P_2O_5/fed) to obtain the highest seed cotton yield/fed, its components and consequently to get the highest values of net income/fed and this should be considered in growing cotton crop on the newly reclaimed calcareous soil of West Nubaria region.

The expansion in using biofertilizers in Egypt depends on : Firstly, training farmers and extention agents on the best storage and manipulation methods of biofertilizers such that the activity of phosphate-solubilizing bacteria (PSB) will continue until seed inoculation. Secondly, in case of treating the seeds with fungicides and pesticides, inoculation with biofertilizers should be delayed until seed germination and the application will be carried out by injection into the soil.

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الملخص العربي

مستقبل إنتاج القطن المصري في الأراضي الصحراوية المستصلحة حديثاً بمصر

٨- استجابة القطن للتلقيح بالبكتيريا المذيبة للفوسفور والتسميد الفوسفورى المعدنى

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هذه هى الحلقة الثامنة فى سلسلة البحوث الخاصة بالنهوض بإنتاجية القطن فى الأراضى الجديدة. وقد أجريت هذه التجربة بمحطة البحوث الزراعية بالنوبارية – فى أرض جيرية – خلال موسمى الصيف ١٩٩٩ ، ٢٠٠٠ ميلادية. وذلك لدراسة إستجابة صنف القطن المصرى الفائق طول التيلة "جيزة ٧٠" للتلقيح بالسماد التجارى الحيوى المصرى "فوسفورين" – والمحتوى على بكتيريا متخصصة فى زيادة صلاحية الفوسفور لإمتصاصه بواسطة جذور نباتات القطن من التربة – مقارنة بمعاملة الكنترول (بدون تلقيح) تحت مستويات مختلفة من التسميد الفوسفورى المعدنى (٧,٥ ، ١٥,٠ ، ٢٢,٥ كجم حمض فوسفوريك/فدان) وتفاعلهما على دلائل النمو وقياسات التبكير ومحصول القطن الزهر/فدان ومكوناته وخواص التيلة وصافى الدخل/فدان. وقد أستخدم فى هذه التجربة تصميم القطع المنشقة مرة واحدة فى أربع مكررات ، وكانت النتائج الموجزة كما يلى : (١) أدت إضافة السماد الفوسفاتى المعدنى بالمستوى المرتفع (٢٢,٥ كجم حمض فوسفوريك/فدان) إلى زيادة جوهرية فى قياسات التبكير ، عدد اللوز المتفتح/نبات ، محصول النبات الفردى من القطن الزهر ، محصول الفدان من القطن الزهر ، قيمة الدخل الناتج/فدان وبالتالى أعلى قيمة لصافى الدخل/فدان وذلك خلال موسمى ١٩٩٩ ، ٢٠٠٠ ميلادية ، بينما لم تؤثر مستويات التسميد الفوسفاتى جوهرياً على متوسط وزن اللوزة ، تصافى الحليج فى موسم واحد فقط ، طول النبات ، عدد الأفرع الثمرية/نبات ، عدد النباتات/فدان عند الجنى وخواص التيلة فى كلا الموسمين. (٢) أعطت معاملة تلقيح بذور القطن بالمخصب الفوسفورى الحيوى "فوسفورين" زيادة معنوية فى طول النبات ، عدد الأفرع الثمرية/نبات ، قياسات التبكير ، محصول القطن الزهر/فدان ومكوناته ، صافى الدخل/فدان ومكوناته وذلك مقارنةً بالكنترول (عدم التلقيح) فى كلا الموسمين ، بينما لم تختلف معاملة تلقيح بذورالقطن بالفوسفورين عن الكنترول (عدم التلقيح) جوهرياً فى صفات عدد النباتات/فدان عند الجنى ، تصافى الحليج وخواص التيلة فى كلا الموسمين. (٣) كان للتداخل من الدرجة الأولى (التسميد الفوسفاتى المعدنى × التسميد بالمخصبات الحيوية) تأثير جوهرى على عدد كبير من الصفات المحصولية والإقتصادية لنبات القطن تم تقييمها ودراستها بعناية. (٤) أهم تأثيرات التداخل من الدرجة الأولى الجوهرية تؤكد على أن تلقيح بذور القطن بالمخصب الحيوى الفوسفاتى "فوسفورين" مع التسميد بالمستوى المرتفع من الفوسفور (٢٢,٥ كجم حمض فوسفوريك/فدان) قد أدى إلى الحصول على زيادات جوهرية فى محصول القطن الزهر/فدان (٦,٣٩ ، ٥,٦٠ قنطار) وبالتالى أعلى صافى دخل/فدان (٢٠٠٩ ، ١٣٧٦ جنيه مصرى) خلال موسمى نمو القطن ١٩٩٩ ، ٢٠٠٠ ميلادية على الترتيب وذلك مقارنةً بباقى معاملات التجربة وذلك فى الأراضى الجيرية المستصلحة حديثاً بغرب النوبارية.