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RESPONSE OF WHEAT AND BROAD BEAN PLANTS TO PHOSPHORUS UNDER DIFFERENT SOIL CONDITIONS

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Abstract

This study was conducted on ten surface soil samples of Egypt to evaluate the effect of their properties on response of wheat (*Triticum Aesticum, Sakha 69*) and broad bean (*Vicia Faba,* Giza 429) plants to P fertilization. The collected soil samples have wide variation in their physical and chemical properties. A pot experiment was carried out at Bahtim Experimental Research Station. The pots were arranged in a split plot design in five replicates. The pots were treated with KH_2PO_4. $2H_2O$ as P-fertilizer at rates of 0, 20, 40 and 80 ppm P. After 60 and 90 days of germination, the plant sample of one replicate was harvested and the other three replicates were harvested after 140 days. The grains and seeds in the latter three replicates were separated from the other plant parts.

The obtained data show that, dry matter yield of wheat and broad bean plants (g/pot) increased with the increase of added P and growth period. The highest yield of dry matter was found with application rate of P at 40 ppm. In most treatments, the obtained dry matter yield of wheat was more than that of broad bean. The dry matter yield of plants grown on alluvial (non calcareous) soils was higher than that planted on calcareous soils. The relative increase (%) of broad bean dry matter yield was higher than that of wheat dry matter yield. The agronomical efficiency of P-fertilizer increased with the increase of growth period. The highest agronomical efficiency of added P was found with the application rate of 20 ppm P. The agronomical efficiency of P for wheat plants grown on calcareous soils was higher than that grown on alluvial soils where its values for broad bean plants planted on alluvial soils were more than those for plants grown on calcareous soils. The correlation coefficients (r) between the dry matter yield of either wheat or broad bean and either of silt, clay, total-P, OM or CEC were positive; but negative with either sand, $CaCO_3$ or EC.

Key wards: Phosphorus, Wheat, Broad bean, Growth period, Agronomical efficiency, Soil properties.

INTRODUCTION

Phosphorus is very important element to plant growth. It plays a key role in metabolic process such as the conversion of sugar into starch and cellulose. As a result, phosphorus deficiency causes stunting, delayed maturity and shriveled seeds. Phosphorus in the fertilizer is often more soluble for plants than the native soil phosphorus (Follett *et al.*, 1981). On the other hand, the physical and chemical soil properties play an important role in the reaction and status of phosphate ions. Many studies have been conducted to determine the effect of soil properties on the release and retention of both residual and added phosphorus. Also, phosphate sorption in soils was used as an important index to evaluate the availability of soil phosphorus for plant. Ahmed, *et al.*, (1990) found that phosphate adsorption and hence its availability varied depending on mineralogical, physical and chemical properties, as well as management history of soils.

The relative importance of soil components in P sorption and desorption, consequently its availability, involves evaluation of P sorption and desorption by "pure" soil components, and comparison of the obtained results to the expected form, amount, and distribution of similar components in soil. In this respect, sorption and desorption of phosphorus by soils have been extensively studied. The P reactions and its availability are generally affected by many factors such as soil pH, type of clay minerals, reactive surface containing, e.g., iron, aluminum, calcium, etc. .. and surface area of particles (Hall and Barker, 1971). Low phosphorus availability to growing plants on different soils was noticed especially in arid and semi arid hot regions. The low efficiency of phosphate fertilizer was found, which was generally attributed to the phosphate retention phenomenon by soil components. (El-Attar, *et al.*, 1986).

This work was carried out to study the effect of some factors on the plant response to phosphorus fertilizer. The factors under study were plant species, growth period, rate of added P and soil properties: i.e. soil content of sand, silt, clay, $CaCO_3$, OM and total P as well as soil pH, EC and CEC.

MATERIALS AND METHODS

This study was conducted on ten surface soil samples (0-30cm) have wide variations in their physical and chemical properties especially the content (%) of $CaCO_3$ and clay. The first five samples (1-5), representing alluvial non calcareous soils, were collected from El-Kalioubiya Governorate. The other five soils samples (6-10) were collected from El-Nobariya region to represent the calcareous soils. The sampling locations were listed in Table 1. The collected samples were thoroughly mixed, air-dried, ground, sieved through a 2 mm sieve and kept for analysis. The samples were analyzed for some physical and chemical properties (Black, 1965 and Jackson, 1973) and the obtained data were recorded in Table 1.

A pot experiment was carried out at Bahtim Experimental Research Station during the winter season (1997/1998). Plastic pots of 20 cm diameter and 20 cm depth were used in this work. The pots were filled with collected soil samples (3 kg/pot). The pots were arranged in a split plot design in five replicates. Pots of each soil were treated with $KH_2PO_4.2H_2O$ (di-hydrogen potassium phosphate) as phosphate fertilizer at rates of 0, 20, 40 and 80 ppm P. The pots of each soil were devided to two subgroups. The first subgroup was planted with four seeds of broad bean (*Vicia Faba, Giza 429 Variety*) and the second subgroup was planted with fifteen grains of wheat (*Triticum Aesticum L. Saka 69 variety*) for each pot. The pots were irrigated by tap water at the field capacity for each soil. After 10 days of planting, the plants were thinned to 2 and 10 plants for broad bean and wheat, respectively. The plants were treated with N and K fertilizers at the recommended doses of the planted crops, where nitrogen fertilizer was added as ammonium sulfate [$(NH_4)_2SO_4$-20.5% N] at rates of 60 and 30 mg N/kg soil for wheat and broad bean respectively, while K was added at 100 mg K_2O/kg soil as potassium sulfate (K_2SO_4 - 48.50% K_2O) with correction for K applied with P fertilizer. Micronutrients (Fe, Mn, Zn, Cu, B and Mo) were added as a solution application (one Hoagland nutrient strength) after 40 days from planting. The moisture content in the pots remained at the field capacity of the soils by adding the tap water every two days. After 60 and 90 days of planting the plant samples of one replicate were harvested and the other three replicates were harvested after 140 days from planting. In the latter samples, the seeds were separated from the other plant parts. The harvested plants were washed by tap water three times and by distilled water three times, air

Table 1. Physical and chemical properties of the used soils.

	Soil properties	Alluvial soils (El-Kalioubiya Governorate).					Calcareous soils (El-Nobariya region)				
		(1) El-Hesania	(2) Kafr Hamza	(3) Abo Zable	(4) El-Kalag	(5) Bahtim	(6) Bahig	(7) North Phlastin	(8) Phlastin	(9) El-Bostan	(10) El-Sadat
Physical	Particles size distribution										
	Sand %	34.96	12.41	68.72	55.20	19.88	54.56	43.67	53.60	84.71	88.89
	Silt %	21.97	11.27	6.18	2.76	24.86	2.21	25.32	13.45	3.66	0.99
	Clay %	43.07	76.32	25.10	42.04	55.26	43.23	31.01	32.95	11.63	10.12
	Texture grade	Clay	Clay	Sandy clay	Sandy clay	Clay	Sandy clay	Sandy clay	Sandy clay	Sandy	Sandy
	W.H.C.	50.00	60.00	29.00	92.00	59.00	31.00	47.00	46.00	21.00	21.00
Chemical	pH (1:2.5) soil: water susp.	7.50	8.10	8.00	8.20	8.10	7.90	8.00	8.30	8.00	7.90
	E.C. dSm^{-1}	1.90	2.40	1.70	2.75	6.25	11.50	7.20	16.80	8.40	2.50
	OM (%)	2.46	2.76	1.52	1.75	2.41	1.47	1.33	1.67	1.02	0.74
	$CaCO_3$ (%)	3.60	4.00	2.00	2.80	3.20	22.40	33.20	36.80	13.60	6.40
	CEC (meq/100g)	39.62	53.43	15.00	21.00	50.28	22.56	26.74	28.56	12.00	9.00
	Amorphous oxides (%)										
	Fe_2O_3	6.20	6.60	3.80	5.20	8.40	4.60	6.00	3.00	2.70	1.80
	Al_2O_3	12.54	14.74	6.86	11.90	9.71	5.76	6.27	5.01	5.69	2.09
	Soluble ions meq/L										
	Na^+	8.75	9.55	6.45	18.85	56.96	86.84	44.96	143.50	45.50	15.75
	K^+	0.90	0.60	0.61	0.66	0.78	1.96	1.65	7.86	2.04	0.98
	Ca^{2+}	8.37	8.32	7.32	5.20	8.32	57.44	20.20	41.10	33.28	11.48
	Mg^{2+}	1.58	5.54	2.58	3.71	3.56	20.97	14.84	33.64	21.17	7.33
	Cl^-	8.00	8.00	4.00	16.00	48.00	62.00	30.00	98.00	18.00	9.00
	HCO_3^-	3.18	5.65	4.93	2.55	3.19	6.38	10.20	13.00	9.38	6.48
	SO_4^{2-}	8.37	10.66	8.03	9.85	18.43	78.83	20.05	115.30	74.61	12.06
	P-content (ppm)										
	Total	630.00	848.00	739.00	587.00	935.00	500.00	674.00	587.00	413.00	348.00
	Available	4.00	4.70	5.00	3.90	4.20	3.80	7.20	7.30	3.80	3.80

dried, oven dried at 70°C until the weights became constant. The results were statistically analyzed using Costa computer package to calculate the correlation and regression analysis, SAS Institute, (1985).

RESULTS AND DISCUSSION

Data in Table 2 show that, dry matter yield (g/pot) of wheat and broad bean plants (straw and grains or seeds) significantly increased with the increase growth period and added P up to 40 ppm. At the rate of 80 ppm P the increase of dry matter yield of plants planted in some soils was slight and even decreased in the others. In most soils, the dry matter yield of broad bean response to added P was higher than that of wheat. This result was shown from the values of dry matter relative increase (RI, %) of wheat and broad bean plants presented in Table 3. This effect resulted from the low dry matter of broad bean plants grown in the soils untreated by P-fertilizer. The increase rate of dry matter yield of the two used crops at the same added P-level decreased with the increase of the growth period. The relationships and correlation coefficients (r) between the rates of P-application and the dry matter yield of wheat and broad bean plants were calculated and recorded in Table 4. The obtained linear equation and correlation coefficients indicate good relationships between added P to different used soils and the dry matter yield (straw and grains) of wheat and broad bean plants at different growth periods. In all studied treatments the values of (r) were positive and they were significant with rates of 20 and 40 ppm of added P. The significance of the obtained correlation coefficients were more clear for the plants grown in alluvial soils, also it is more significant for wheat compared with broad bean. These results are in agreement with those obtained by Reddy and Yadav (1994).

Data in Table 5 show the agronomical efficiency (yield increase per unit of P-applied) of wheat and broad bean plants at different growth periods and P-application rates under different soil conditions. Generally, the values increased with the increase of growth period. Also in most cases, the rate of 20 ppm P produced the highest values of agronomical efficiency compared with those found with the high levels of added P. At the same level of added P, the high agronomical efficiency for the two tested plants was found at the growth period of 140 days. Under most studied treatments, the agronomical efficiency of wheat plants grown on calcareous soils was higher than

Table 2. Dry matter (DM) yield (g/pot) of wheat and broad bean plants (straw and grains) at different growth periods as affected by application level of phosphorus (ppm) in different soils of Egypt.

Crop	Soil No.	Straw												Grains			
		Growth period (day)															
		60				90				140							
		P-level (ppm)				P-level (ppm)				P-level (ppm)				P-level (ppm)			
		0	20	40	80	0	20	40	80	0	20	40	80	0	20	40	80
Wheat	1	5.98	6.58	7.11	7.16	19.23	20.20	20.35	20.55	25.29	27.44	28.77	28.86	6.60	7.90	8.20	8.40
	2	12.76	13.10	13.64	13.98	29.58	38.93	39.97	42.80	45.33	47.69	48.38	51.15	15.60	16.20	17.00	17.00
	3	6.07	6.16	6.25	6.36	19.80	22.99	23.13	23.73	26.36	26.83	27.80	27.90	9.20	10.30	10.80	10.50
	4	9.07	9.67	9.63	10.05	26.72	27.95	31.62	31.93	34.23	35.07	40.15	40.29	13.20	16.10	17.10	17.30
	5	8.58	10.68	12.20	12.27	33.76	34.00	34.31	39.48	48.11	50.89	51.49	52.44	13.40	15.80	17.40	17.70
	6	1.85	3.33	3.59	3.65	7.49	7.91	8.35	9.34	15.00	21.04	21.95	21.51	5.40	9.50	10.70	10.50
	7	8.58	10.00	11.93	11.94	28.27	30.77	31.10	31.43	39.11	43.32	43.50	43.97	13.60	14.60	15.70	15.80
	8	1.68	2.03	2.28	2.72	8.00	9.87	10.00	12.99	11.00	18.10	18.42	18.51	6.40	7.20	7.50	7.50
	9	1.97	4.68	5.07	5.08	7.21	16.18	16.97	16.98	13.01	20.59	22.49	22.66	4.60	7.70	7.80	8.30
	10	2.79	5.30	6.00	5.96	13.42	15.38	16.09	18.50	21.17	24.92	25.32	25.40	8.70	10.70	10.90	11.10
Broad bean	1	3.70	4.72	5.60	5.70	15.80	18.97	19.38	20.84	21.42	23.57	26.60	26.66	7.20	7.80	8.90	9.00
	2	6.90	8.03	8.78	8.85	27.87	30.00	32.64	32.96	38.27	43.60	44.90	44.90	12.10	13.50	15.40	15.40
	3	4.77	5.18	6.60	6.65	15.94	16.44	18.77	20.12	28.98	30.10	30.73	30.76	10.50	11.90	12.00	12.20
	4	5.56	7.53	7.75	7.93	18.34	2.84	24.30	24.82	28.21	33.40	35.89	37.54	9.60	10.20	12.40	13.70
	5	5.00	6.00	6.63	7.22	23.54	25.04	26.43	28.37	25.42	42.55	46.01	46.64	12.70	15.90	16.00	16.00
	6	1.95	2.31	3.04	3.11	7.42	9.27	9.79	9.81	12.37	14.69	19.97	25.95	4.90	5.70	6.90	7.00
	7	5.37	6.25	6.70	6.93	13.31	17.98	18.00	18.20	29.57	30.64	32.50	32.71	10.30	10.90	13.00	14.30
	8	0.27	0.34	0.55	0.56	2.98	3.71	3.79	3.79	4.61	4.81	5.02	5.97	0.80	0.90	1.10	1.40
	9	2.62	2.88	3.89	3.90	6.71	8.81	10.14	12.76	13.00	16.61	17.97	17.99	4.30	5.30	6.30	6.40
	10	3.70	4.48	5.06	5.42	7.80	9.88	10.20	12.34	19.19	20.25	25.00	25.31	6.20	6.90	7.50	8.50

* 1-5 = Alluvial or non calcareous soils & 6-10 = Calcareous soils

Table 3: Relative increase (RI, %) of dry matter (DM) yield of wheat and broad bean plants (straw and grains) at different growth periods as affected by application level of phosphorus (ppm) in different soils of Egypt.

Crop	Soil No.	Straw									Grains		
		Growth period (day)											
		60			90			140					
		P-level (ppm)			P-level (ppm)			P-level (ppm)			P-level (ppm)		
		20	40	80	20	40	80	20	40	80	20	40	80
Wheat	1	10.03	18.90	19.73	5.04	5.82	6.86	8.50	13.76	14.12	19.70	24.24	27.27
	2	1.96	6.90	9.56	31.61	35.13	44.69	5.21	6.73	10.63	3.85	8.97	8.97
	3	2.50	2.97	4.78	16.11	16.82	19.85	1.78	5.46	5.84	11.96	17.39	14.13
	4	6.62	6.17	10.80	4.60	18.34	19.50	2.45	17.29	17.70	21.97	29.55	31.06
	5	24.48	42.19	43.01	0.71	1.63	16.94	5.87	7.03	9.00	17.91	29.85	32.09
	6	80.00	94.05	97.30	5.61	11.48	24.70	40.27	46.33	43.40	75.93	98.15	94.44
	7	16.55	39.04	39.16	8.84	10.01	11.18	10.76	11.22	12.43	7.35	15.44	16.18
	8	20.83	35.71	61.90	23.38	25.00	62.38	64.55	67.45	68.27	12.50	17.19	17.19
	9	137.56	157.36	157.87	124.41	135.37	135.51	58.26	72.87	74.17	67.39	69.57	80.43
	10	89.96	115.05	113.62	14.61	19.90	37.85	17.71	19.60	19.98	22.99	25.29	27.59
Broad bean	1	27.57	51.35	54.05	20.06	22.66	31.90	10.04	24.18	24.46	8.33	23.61	25.00
	2	16.38	27.25	28.26	7.64	17.12	18.26	13.93	17.32	17.32	11.57	27.27	27.27
	3	8.60	38.36	39.41	3.14	17.75	26.22	3.86	6.04	6.14	13.33	14.29	16.19
	4	35.43	39.39	42.63	24.54	32.50	35.33	18.40	27.22	33.07	6.25	29.17	42.71
	5	20.00	32.60	44.40	6.37	12.28	20.52	67.39	81.00	83.48	25.20	25.98	25.98
	6	18.46	55.90	59.49	24.93	31.94	32.21	18.76	61.44	109.78	16.33	40.82	42.86
	7	16.39	24.77	29.05	35.09	35.24	36.74	3.62	9.91	10.62	5.83	26.21	83.83
	8	25.93	103.70	107.41	24.50	27.18	27.18	4.34	8.89	29.50	12.50	37.50	75.00
	9	9.92	48.47	48.85	31.30	51.12	90.16	27.77	38.23	38.38	23.26	46.51	48.84
	10	21.08	36.76	46.49	26.67	30.77	58.21	5.52	30.28	31.89	11.29	20.97	37.10

* 1-5 = Alluvial or non calcareous soils & 6-10 = Calcareous soils

Table 4. Relationships (linear equations) and correlation coefficients, (r) between dry matter yield (g/pot) (X) of wheat and broad bean (straw and grains) and added P-level (ppm) (Y) at different treatments under study.

Crop	Soil No.	Growth period (day)							
		60		90		140		Grains or seeds	
		Equation	r	Equation	r	Equation	r	Equation	r
Wheat	1	Y = -330.7 + 54.5 X	0.88	Y = -1041.0 + 53.5X	0.85	Y = -448.6 + 17.5 X	0.85	Y = -239.6 + 35.3 X	0.83
	2	Y = -749.8 + 58.8 X	0.97	Y = -159.4 + 5.1 X	0.86	Y = -754.0 + 16.4 X	0.96	Y = -686.9 + 43.8 X	0.87
	3	Y = -1658.6+272.7X	0.99	Y = -311.9 + 15.4 X	0.80	Y = 184.0 – 6.0 X	-0.80	Y = -314.3 + 34.2 X	0.69
	4	Y = -709.2 + 77.4 X	0.91	Y = -311.4 + 11.7 X	0.89	Y = -310.5 + 9.21 X	0.87	Y = -203.2 + 14.9 X	0.82
	5	Y = -150.5 + 16.9 X	0.86	Y = -368.7 + 11.4 X	0.91	Y = -795.1 + 16.3 X	0.89	Y = -210.3 + 15.2 X	0.87
	6	Y = -62.1 + 31.2 X	0.77	Y = -320.7 + 43.0 X	0.99	Y = -111.7 + 7.3 X	0.70	Y = -60.6 + 10.6 X	0.76
	7	Y = -159.4 + 18.3 X	0.88	Y = -545.3 + 19.0 X	0.80	Y = -457.0 + 11.5 X	0.77	Y = -401.9 + 29.2 X	0.88
	8	Y = -133.9 + 77.6 X	0.99	Y = -130.1 + 16.2X	0.97	Y = -74.3 + 6.61 X	0.71	Y = -344.5 + 53.0 X	0.80
	9	Y = -33.2 + 14.5 X	0.94	Y = -39.4 + 5.1 X	0.72	Y = -81.6 + 5.91 X	0.78	Y = -78.0 + 15.9 X	0.78
	10	Y = -52.9 + 16.0 X	0.77	Y = -220.0 + 16.0 X	0.98	Y = -267.3 + 12.4 X	0.74	Y = -213.2 + 23.9 X	0.78
Broad bean	1	Y = -124.7 + 32.3 X	0.88	Y = -238.4 + 14.5 X	0.90	Y = -255.3 + 11.8 X	0.88	Y = -254.4 + 35.1 X	0.89
	2	Y = -230.0 + 32.6X	0.86	Y = -360.1 + 12.8 X	0.89	Y = -325.7 + 8.4 X	0.77	Y = -227.3 + 18.6 X	0.87
	3	Y = -145.9 + 31.1 X	0.88	Y = -263.3 + 16.7 X	0.96	Y = -1009.2 + 34.6X	0.84	Y = -370.4 + 34.8 X	0.79
	4	Y = -139.2 + 24.2 X	0.78	Y = -185.2 + 9.7 X	0.84	Y = -223.0 + 7.6 X	0.91	Y = -163.6 + 17.3 X	0.96
	5	Y = -178.7 + 34.4 X	0.95	Y = -391.6 + 16.5 X	0.99	Y = -72.4 + 2.6 X	0.78	Y = -186.2 + 14.6 X	0.69
	6	Y = -106.6 + 54.4 X	0.90	Y = -182.1 + 23.9 X	0.79	Y = -67.3 + 5.6 X	0.99	Y = -150.9 + 30.3 X	0.89
	7	Y = -247.2 + 44.7 X	0.90	Y = -137.6 + 10.2 X	0.71	Y = -605.8 + 20.4 X	0.90	Y = -181.6 + 17.8 X	0.97
	8	Y = -53.6 + 206.1 X	0.88	Y = -191.9 + 63.6 X	0.73	Y = -247.6 + 55.4 X	0.97	Y = -100.0 + 128.5X	0.99
	9	Y = -113.3 + 44.6 X	0.87	Y = -93.6 + 13.3 X	0.99	Y = -157.8 + 11.7 X	0.81	Y = -136.7 + 30.7 X	0.88
	10	Y = -164.9 + 42.8 X	0.94	Y = -144.6 + 17.8 X	0.97	Y = -179.7 + 9.5 X	0.88	Y = -219.2 + 34.9 X	0.99

Table 5. The agronomical efficiency** of dry matter yield (straw and grains) of wheat and broad bean plants at different growth periods as affected by growth period and rate of P-application in different soils of Egypt.

Crop	Soil No.	Straw									Grains		
		Growth period (day)											
		60			90			140					
		P-level (ppm)			P-level (ppm)			P-level (ppm)			P-level (ppm)		
		20	40	80	20	40	80	20	40	80	20	40	80
Wheat	1	0.030	0.029	0.015	0.049	0.028	0.005	0.108	0.087	0.045	0.065	0.040	0.023
	2	0.013	0.022	0.015	0.468	0.260	0.165	0.118	0.760	0.048	0.030	0.035	0.018
	3	0.007	0.006	0.005	0.160	0.083	0.044	0.024	0.036	0.019	0.055	0.040	0.016
	4	0.027	0.014	0.012	0.062	0.123	0.065	0.108	0.148	0.076	0.145	0.098	0.051
	5	0.105	0.091	0.041	0.012	0.014	0.072	0.139	0.091	0.054	0.120	0.100	0.045
	6	0.074	0.044	0.023	0.026	0.022	0.023	0.302	0.174	0.094	0.205	0.013	0.064
	7	0.071	0.065	0.043	0.125	0.079	0.040	0.211	0.110	0.061	0.150	0.103	0.053
	8	0.018	0.015	0.013	0.094	0.050	0.062	0.355	0.186	0.094	0.040	0.028	0.014
	9	0.136	0.078	0.039	0.449	0.244	0.122	0.379	0.237	0.121	0.155	0.080	0.046
	10	0.175	0.080	0.040	0.096	0.067	0.064	0.188	0.104	0.053	0.100	0.055	0.030
Broad bean	1	0.061	0.048	0.025	0.160	0.090	0.063	0.108	0.130	0.062	0.030	0.043	0.023
	2	0.057	0.047	0.024	0.106	0.119	0.063	0.167	0.166	0.083	0.070	0.083	0.041
	3	0.021	0.046	0.024	0.025	0.045	0.052	0.056	0.044	0.022	0.070	0.038	0.021
	4	0.099	0.050	0.028	0.225	0.354	0.081	0.260	0.190	0.117	0.030	0.070	0.051
	5	0.050	0.041	0.028	0.140	0.072	0.055	0.857	0.398	0.259	0.160	0.083	0.041
	6	0.018	0.027	0.015	0.093	0.064	0.030	0.116	0.190	0.170	0.090	0.050	0.026
	7	0.044	0.033	0.020	0.234	0.067	0.062	0.054	0.073	0.039	0.030	0.068	0.050
	8	0.004	0.007	0.004	0.012	0.020	0.010	0.010	0.010	0.017	0.005	0.008	0.008
	9	0.013	0.032	0.012	0.105	0.086	0.076	0.181	0.124	0.062	0.050	0.050	0.026
	10	0.039	0.034	0.022	0.104	0.060	0.057	0.053	0.145	0.077	0.035	0.033	0.029

* 1-5 = Alluvial or non calcareous soils & 6-10 = Calcareous soils

$$** \text{ Agronomical efficiency} = \frac{\text{Crop yields (fertilized) - Crop yields (control)}}{\text{P - added}}$$

(Sisworo *et al.*, 1990)

that for plants grown on alluvial soils. On the other hand the high values of agronomical efficiency of broad bean plants were found in the plants grown on the alluvial soils. The results of agronomical efficiency of wheat grains and broad bean seeds yield were in agreement with those found with straw yield. Except the treatments of 40 and 80 ppm of added P in the growth period of 140 days, the mean values of agronomic efficiency for wheat (straw and grains) were higher than those of broad bean (straw and seeds). These data may indicate that the response of wheat plant to phosphatic fertilization was more than that of broad bean especially in calcareous soils. The low agronomical efficiency values of broad bean may indicate the high requirement of broad bean for phosphatic fertilizers especially in the earlier growth periods. Also, data in Table 5 show that, the growth response of wheat plants grown on calcareous soils was more pronounced with P application than that for alluvial soils. On the other hand, response of broad bean to added P in alluvial soils was more than that in calcareous soils. These results are in harmony with those obtained by Doris Fohse *et al.,* (1988), Hammad *et al.,* (1990) and Negm *et al.,* (1997).

Data in Table 2 show the effect of ten soil types having different properties (Table, 1) on dry matter yield of wheat and broad bean plants. Data indicated that, the alluvial soil collected from Kafr Hamza (No. 2) gave the highest production of dry matter of straw for both wheat and broad bean plants. Also, the highest values of dry matter yield of straw in calcareous soils were found with wheat and broad bean plants grown on N-Phlastin. On the other hand, the high yield of wheat grains was obtained from the plants grown on El-Kalag soil (No. 4) followed by those planted in Bahtim soil (No. 5) where the highest values of broad bean seeds yield were found in the plants grown on Bahtim soil (No. 5) followed by those planted in Kafr Hamza soil (No. 2). The arrangement of used soils according to the general mean of dry matter yield (g/pot) calculated from the recorded data in Table 2 was as follows: soil No. 2 (32.95) > 5 (32.35) > 7 (27.83) > 4 (25.49) > 3 (18.59) > 1 (18.13) > 10 (15.02) > 9 (12.74) > 6 (10.50) > 8 (9.55 g/pot) for wheat straw, soil No. 2 (27.29) > 5 (24.07) > 4 (21.22) > 3 (17.92) > 7 (16.22) > 1 (16.02) > 10 (12.39) > 6 (9.97) > 9 (9.77) > 8 (4.00 g/pot) for broad bean straw, soil No. 2 (16.45) > 5 (16.08) > 4 (15.93) > 7 (14.43) > 10 (10.35) > 3 (10.20) > 6 (9.03) > 1 (7.78) > 8 (7.15) 9 (7.10 g/pot) for wheat grains and soil No. 5 (15.15) > 2 (14.10) > 7 (12.13) > 3 (11.65) > 4 (11.48) > t

(8.23) > 10 (7.28) > 6 (6.38) > 9 (5.58) > 8 (1.05 g/pot) for broad bean seeds. This arrangement indicate that the highest dry matter yield (straw and grains) were found in the plants grown on alluvial soils. Similar results were reported by Ismail *et al.*, (1986) and Shama (1996).

The wide variations in the obtained dry matter yields may be attributed to the different relationships between soil properties and dry matter yield. The data in Table 6 show the relationships and correlation coefficients (r) between soil properties and dry matter yield (g/pot) of wheat and broad bean plants (straw and grains) treated by various levels of P-fertilizer at different growth periods. The obtained linear equations and correlation coefficients indicate significant and positive correlation between dry matter yield (straw and grains) of wheat and broad bean plants and either of silt, clay, CEC, total. P and OM contents, where these correlations were negative with sand, EC and $CaCO_3$ contents. The negative effect of sand, $CaCO_3$ and EC decreased with the increase of both growth period and added P. The negative correlation coefficients especially with $CaCO_3$ and EC reveal its negative effect on plant growth. This negative effect may be attributed to the precipitation of both soil and added P as a result of reaction between P and $CaCO_3$ where its precipitation as relatively insoluble di-calcium phosphate and other basic calcium phosphate such as hydroxy-appatite and carbonate-appatite (Zaghloul, 1998). Francois *et al.*, (1986) found that, the growth of broad bean and wheat plants decreased with the increase of soil salinity. The values of (r) presented in Table 6 show that, the effect of soil properties under study on plant growth varied from growth period to another.

Table 6. Relationships (Linear equation and correlation coefficients, r) between dry matter yield (X) of wheat and broad bean plants and soil properties; at different treatments under study.

Crop	(y) Straw						Grains or seeds	
	Growth period (days)							
	60		90		140			
	Equation	r	Equation	r	Equation	r	Equation	r
Wheat	DMY = 12.77 - 0.1016 x Sand	-0.71	DMY = 39.06 - 0.29 x Sand	-0.66	DMY = 49.42 - 0.35 x Sand	-0.72	Grains = 16.09 - 0.09 x Sand	-0.58
	DMY = 17.20 + 0.03 x Silt	0.08	DMY = 23.80 + 0.03 x Silt	0.03	DMY = 23.61 + 0.67 x Silt	0.52	Grains = 10.24 + 0.11 x Silt	0.27
	DMY = 1.74 + 0.16 x Clay	0.86	DMY = 7.25 + 0.46 x Clay	0.82	DMY = 15.91 + 0.41 x clay	0.66	Grains = 7.04 + 0.12 x clay	0.61
	DMY = -39.06 + 5.82 x pH	0.35	DMY = -138.7 + 20.36 x pH	0.40	DMY = -46.38 + 9.69 x pH	0.17	Grains = -41.08 + 6.57 x pH	0.37
	DMY = 7.23 + 0.048 x EC	0.07	DMY = 23.04 - 0.18 x EC	0.08	DMY = 38.34 - 1.177 x EC	-0.73	Grains = 13.46 - 0.33 x EC	-0.42
	DMY = 8.18 - 0.05* $CaCO_3$	-0.19	DMY = 26.55 - 0.16* $CaCO_3$	-0.23	DMY = 35.62 - 0.35* $CaCO_3$	-0.80	Grains = 12.63 - 0.09 x $CaCO_3$	-0.32
	DMY = 2.95 + 0.16 x CEC	0.71	DMY = 10.94 + 0.47 x CEC	0.67	DMY = 16.08 + 0.54 x CEC	0.68	Grains = 7.95 + 0.13 x CEC	0.50
	DMY = 1.05 + 3.84 x OM	0.75	DMY = 5.03 + 11.34 x OM	0.72	DMY = 13.88 + 10.22 x OM	0.58	Grains = 7.57 + 2.30 x OM	0.42
	DMY = 0.70 + 0.007 x TP	0.58	DMY = -2.15 + 0.03 x TP	0.75	DMY = -0.12 + 0.04 x TP	0.71	Grains = 3.61 + 0.013 x TP	0.65
Broad bean	DMY = 7.16 - 0.04 x Sand	-0.47	DMY = 27.14 - 0.21 x Sand	-0.68	DMY = 41.16 - 0.28 x Sand	-0.58	Seeds = 14.31 - 0.10 x Sand	-0.56
	DMY = 4.4 + 0.04 x Silt	0.18	DMY = 12.95 + 0.29 x Silt	0.35	DMY = 22.04 + 0.41 x Silt	0.33	Seeds = 7.45 + 0.16 x Silt	0.36
	DMY = 2.69 + 0.06 x Clay	0.51	DMY = 6.04 + 0.27 x clay	0.69	DMY = 13.62 + 0.35 x Clay	0.58	Seeds = 4.90 + 0.12 x Clay	0.53
	DMY = 3.93 + 0.12 x pH	0.01	DMY = 15.60 + 0.07 x pH	0.00	DMY = 3.07 + 2.95 x pH	0.05	Seeds = 7.07 + 0.20 x pH	0.01
	DMY = 7.17 - 0.37 x EC	-0.79	DMY = 23.04 - 1.12 x EC	-0.71	DMY = 36.87 - 1.66 x EC	-0.69	Seeds = 12.92 - 059 x EC	-0.68
	DMY = 6.28 - 0.11 $CaCO_3$	-0.61	DMY = 21.21 - 0.39 $CaCO_3$	-0.67	DMY = 33.64 - 0.54 $CaCO_3$	-0.60	Seeds = 11.65 - 0.19 $CaCO_3$	-0.56
	DMY = 3.21 + 0.06 x CEC	0.40	DMY = 6.84 + 0.34 x CEC	0.66	DMY = 14.91 + 0.42 x CEC	0.54	Seeds = 5.37 + 0.14 x CEC	0.49
	DMY = 2.51 + 1.42 x OM	0.42	DMY = 3.33 + 7.61 x OM	0.68	DMY = 11.65 + 8.91 x OM	0.52	Seeds = 4.27 + 2.97 x OM	0.47
	DMY = 0.70 + 0.01 x TP	0.58	DMY = -2.15 + 0.03 x TP	0.75	DMY = -0.12 + 0.04 x TP	0.71	Seeds = -0.56 + 0.02 x TP	0.72

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إستجابة نباتات القمح والفول البلدى للسماد الفوسفاتي تحت ظروف أراضى مختلفة

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استخدم فى هذا البحث عشر عينات اراضى سطحية لتقييم تأثير خواصها على استجابة نباتات القمح والفول البلدى للتسميد الفوسفاتي ولقد اختلفت الأراضى المستخدمة اختلافاً كبيراً فى خواصها الطبيعية والكيميائية وقد أقيمت تجربة أصص فى محطة بهتيم للبحوث الزراعية تم تصميمها فى قطع منشقة فى خمسة مكررات حيث عوملت الأصص بفوسفات البوتاسيوم داى هيدروجين (بويد٢فو أ٤.٢يد٢أ) كسماد فوسفاتي عند معدلات إضافة صفر، ٢٠، ٤٠ و ٨٠ جزء فى المليون فوسفور وبعد ٦٠ و ٩٠ يوماً من الإنبات تم حصاد مكررة واحدة من كل معاملة أما المكررات الثلاثة الأخرى فقد تم حصادها بعد ١٤٠ يوم حيث فصلت الحبوب والبذور عن أجزاء النبات الأخرى.

وأوضحت النتائج المتحصل عليها زيادة محصول المادة الجافة (جم/ أصيص) للقمح والفول البلدى بزيادة الفوسفور المضاف ومرحلة النمو. وكان أعلى محصول مادة جافة قد تحصل عليه عند إضافة الفوسفور بمعدل ٤٠ جزء فى المليون ولقد كان محصول المادة الجافة المتحصل عليه من القمح فى معظم المعاملات أعلى من المتحصل عليه من الفول البلدى وكذلك فقد كان محصول المادة الجافة المتحصل عليه من النباتات النامية فى الأراضى الرسوبية أعلى من ذلك المتحصل عليه من النباتات النامية فى الأراضى الجيرية. وكانت الزيادة النسبية (٪) فى محصول المادة الجافة للفول البلدى أعلى من مثيلتها للقمح. وأزدادت فاعلية السماد الفوسفاتي بزيادة مرحلة النمو بحيث كان أعلى فاعلية للفوسفور المضاف عند إضافته بمعدل إضافة ٢٠ جزء فى المليون. كانت فاعلية الفوسفور (كفاءته) مع القمح النامى فى الأراضى الجيرية أعلى عن ذلك النامى فى الأراضى الرسوبية بينما كانت هذه الفاعلية لنباتات الفول البلدى النامية فى الأراضى الرسوبية أعلى من مثيلتها النامية فى الأراضى الجيرية. أخيراً كان معامل الإرتباط بين محصول المادة الجافة للقمح والفول البلدى وأى من السلت والطين والفوسفور الكلى والمادة العضوية والسعة التبادلية الكاتيونية موجباً بينما كان سالباً مع كل من كربونات الكالسيوم ومحتوى الأراضى من الرمل والأملاح الكلية الذائبة.