Egypt. J. Agric. Res., 72 (1), 1994.

CONTRIBUTION OF SOME SOIL PROPERTIES IN PREDICTING CHICK-PEA YIELD

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(Manuscript received 24 February 1992)

Abstract

A field trial was carried out on an alluvial soil at Shandaweel, Upper Egypt to evaluate the contribution of bulk density, total porosity, field capacity, OM and available-P in predicting chick-pea. yield, which received P-fertilizer, OM and gypsum. The results obtained revealed that all soil properties under study were affected positively by the added materials. Field capacity is the direct variable to straw yield, while for seed yield bulk density and field capacity are responsible. Available-P and total porosity are the accepted direct variables for content of protein in seeds.

INTRODUCTION

The use of organic matter and soil amendments under arid and semi arid conditions were studied by several workers to evaluate their contribution in improving the physical and chemical soil properties and consequently plant growth. The importance of phosphatic fertilizers for leguminous crops was reported by many investigators, whereas calcium sulphate and calcium phosphate (in the superphosphate) act as cementing agents which increase soil aggregates and aggregate stability (Asker *et al.* 1986). Moreover, a positive effect of P-fertilizers, FYM and gypsum applications on legumes production in general and especially chick-pea yield was recorded by many investigators (El-Kobbia *et al.* 1969, Roy and Tripathi 1985, Ingole and Deshmukh 1986 and Khadr *et al.* 1988).

The present work aims to study the effect of P-fertilizers, FYM and gypsum applications on some physical & chemical properties of an alluvial soil and their effect on chick-pea production.

MATERIALS AND METHODS

A field trial was conducted on an alluvial soil in 1990-1991 growing season at Shandaweel Agric. Res. Station, Upper Egypt, where the main treatments consisted of four levels of P-fertilizer (0, 15, 30 and 45 kgs P_2O_5/fed.) applied as superphosphate. The subtreatments included 0, 1000 kgs gypsum, 20 m^3 FYM and 500 kgs gypsum + 10 m^3 FYM/fed. All these treatments were arranged in a split plot design and replicated 4 times. The applied materials were mixed with the surface layer (0-30 cm) before sowing chick-pea seeds. A composite soil sample was taken, before the application of P, FYM and gypsum, analyzed and presented in Table 1A. A sample of the applied FYM was analysed for N, C and available P, (Table 1B). Fifteen kgs N/fed. were applied as urea before the first irrigation. At maturity the seeds

Table 1. A. Mechanical and chemical analysis of the studied soil.

Mechanical analysis					Chemical analysis						
Coarse sand	Fine sand	Silt %	Clay %	Soil Texture	O.M. %	CaCO3 %	pH	EC mmhos/ cm.	CEC meq/ 100g	Total N ppm	Available -P ppm
1.03	52.70	24.0	20.12	Sandy clay loam	0.68	1.49	7.10	0.48	19.50	610	11.2

B. Some constituents of FYM.

Total N %	Organic carbon %	C/N ratio	Available -P %
1.80	24.40	12.40	0.40

and straw yields/fed. were recorded, and seed samples were taken to determine their protein content. After harvesting, soil samples were collected from every treatment to evaluate the changes in the physical and chemical properties. The analyses of the soil, FYM and seed samples were conducted as described by Black (1965) and Jackson (1967). The impact of soil characters on chick-pea production was evaluated by calculating stepwise multiple regression according to Draper and Smith (1966).

RESULTS AND DISCUSSION

1. Effect of the applied materials on the soil characteristics:

1.1. Bulk Density:

Data in Table 2 showed a distinct decrease in bulk density values with that of the control as a result of FYM and/or gypsum applications. Application of P-fertilizer in association with the FYM and/or gypsum resulted in improving the bulk values. The decrease in bulk density values reached about 14.8% as that of the control in case of applying 20 m^3 FYM + 45 kgs P_2O_5/fed. The beneficial effect of the forementioned materials is due to the increase in soil organic matter content which consequently encourages soil aggregate formation. These results are in harmony with those obtained by El-Samanoudy *et al.* (1988).

1.2. Total Porosity:

Soil total porosity (Table 2) tended to increase by increasing the amounts of P-fertilizer when applied either alone or with FYM and/or gypsum. For instance the highest values were obtained in case of applying 500 kgs gypsum + 10 m^3 GYM + 45 kgs P_2O_5/fed. In this connection, both OM content and Ca ions enhances the aggregate formation which affects soil porosity values. Previous investigators indicated that the addition of organic materials hold soil aggregates apart keeping pore space or channels when decomposed (Abdel-Ghaffar 1982).

1.3. Field Capacity:

Data shown in Table 2 indicate that the soil moisture content at field capacity

Table 2. Some soil properties as affected by gypsum and FYM applications under different levels of phosphate.

Treatments: Main	Treatments: Sub	Bulk density (g/cm3)	Total porosity (%)	Field capacity (%)	O.M. (%)	Available (ppm)
Control (P1)	Control	1.49	43.77	35.60	0.87	10.00
	1000 kg G/fed.	1.44	45.66	38.90	1.00	11.10
	20 m3 FYM/fed.	1.30	47.57	42.25	1.52	14.20
	500 kg G+10 m3 FYM/fed.	1.43	46.04	40.40	1.25	12.95
15 kg P_2O_5 /fed. (P2)	Control	1.46	44.91	36.75	0.99	10.80
	1000 kg G/fed.	1.40	47.16	38.40	1.17	13.00
	20 m3 FYM/fed.	1.37	48.30	42.70	1.47	16.40
	500 kg G+10 m3 FYM/fed.	1.39	47.45	39.80	1.28	14.90
30 kg P_2O_5 /fed. (P3)	Control	1.42	46.42	37.90	0.96	11.40
	1000 kg G/fed.	1.37	48.30	40.60	1.24	16.65
	20 m3 FYM/fed.	1.31	50.38	44.70	1.67	17.60
	500 kg G+10 m3 FYM/fed.	1.34	49.43	41.90	1.37	15.20
45 kg P_2O_5/fed. (P4)	Control	1.41	46.79	38.60	1.04	12.35
	1000 kg G/fed.	1.35	49.25	41.50	1.35	14.50
	20 m3 FYM/fed.	1.27	50.19	45.60	1.82	19.90
	500 kg G+10 m3 FYM/fed.	1.31	50.75	42.00	1.49	17.60

is positively affected as a result of adding FYM and/or gypsum under different levels of P-fertilizer. The highest increase in this parameter reached 28.1% over the control in case of applying 20 m^3 FYM + 45 Kgs P_2O_5/fed. These results agree with that reported by Asker *et al.* (1986). The improvement in field capacity values as a result of these additions may be attributed to the specific effect of each application on the soil characteristics.

2. Effect of the applied materials on straw & seed yields and seed protein content:

Data in Table 3 revealed that applying P-fertilizer, FYM and/or gypsum resulted in a highly significant increase in both straw and seed yields in conjunction with an increase in the seed content of protein. Straw and seed yields were increased by 160 and 125% respectively as a result of applying 20 m^3 FYM + 30 Kgs P_2O_5/fed. The highest increase in seed protein content was attained in case of adding 20 m^3 FYM + 45 Kgs P_2O_5/fed, as these increases amounted to 72.5% over the control.

3. Stepwise relationships:

It is worthy to note that the application of soil amendments and organic materials to chick-pea plants did not affect the soil properties at once, but their effect occurred gradually during plant growth which resulted in improving of some soil properties as shown in Table 2. Stepwise analysis was carried out to show how far these properties are correlated with the straw and seed yields of chick-pea and protein content of seeds. It aims also to evaluate the accepted and removed variables and their relative contribution R_2% to the yield components (Table 4).

Results could be discussed as follows:

3.1. Straw yield:

The direct affecting variables of straw yield is soil moisture content at field capacity (X3), (Table 4) its relative contribution (R^2%) amounted to 59.22%. The remainder variables: bulk density (X1), total porosity (X2), OM (X4) and available-P (X5) are indirect due to their relative small contribution to this parameter. The best prediction equation is: $Y = -6791.0577 + 228.6045\ X_3$, where Y is the straw yield in Kgs/fed. The relative contribution to all variables (including field capacity) is 66.98%.

Table 3. Seed and Straw yields of chickpea plants and protein of seeds as affected by gypsum and FYM applications under different levels of phosphate.

Treatments		Seed yield (Kg/fed.)	Straw yield (Kg/fed.)	Protein of seed %
Main	Sub			
(P1)	Control	514.50	1416.00	15.19
	1000 kg gypsum/fed.	654.75	1830.75	16.79
	20 m FYM/fed.	690.50	2084.00	18.88
	500 kg gypsum + 10 m3 FYM/fed.	677.50	2026.50	17.63
Mean		634.31	1839.13	17.12
(P2)	Control	708.00	1833.75	15.88
	1000 kg gypsum/fed.	824.75	2510.25	17.84
	20 m FYM/fed.	980.25	2818.00	21.77
	500 kg gypsum + 10 m3 FYM/fed.	839.25	2732.25	18.75
Mean		838.06	2473.56	18.56
(P3)	Control	862.25	1982.00	17.32
	1000 kg gypsum/fed.	1051.50	3155.00	21.06
	20 m3 FYM/fed.	1154.25	3675.50	24.91
	500 kg gypsum + 10 m3 FYM/fed.	1076.00	3478.00	23.25
Mean		1036.00	3078.63	21.64
(P4)	Control	897.50	2094.00	19.06
	1000 kg gypsum/fed.	1095.00	3120.00	22.22
	20 m3 FYM/fed.	1150.50	3283.50	26.21
	500 kg gypsum + 10 m3 FYM/fed.	1099.00	3007.75	24.75
Mean		1060.50	2876.31	23.75
Means of sub	Control	745.56	1831.44	16.86
	gypsum	906.50	2654.00	19.48
	FYM	993.88	2965.25	22.94
	gypsum + FYM	92.93	2811.13	21.09
L.S.D. for P-fert.		34.20	17.25	
for gypsum of/and	FYM	22.99	26.94	
for interaction		45.98	53.88	

Table 4. Direct and indirect variables according to stepwise multiple linear regression and their relative contributions R2% to straw and, seed yields as well as protein content of seeds.

Direct variables	R2%	Indirect variables
I. Straw yield:		
X3 field capacity %	59.22	X1 Bulk density (g/cm3) X2 Total porosity % X4 O.M. % X5 Available -P (ppm)
The best prediction equation: Y=-6791.0577+228.6054X3		
Relative contribution for all variables R2%=66.98		
II. Seed yield:		
X3 field capacity %	25.22	X2 Total porosity %
X1 bulk density, g/cm3	32.47	X4 O.M. % X5 Available -P (ppm)
The best prediction equation: Y=16511.0105-6216.2955X1-166.9351X3		
Relative contribution for all variables R2%=32.97%		
III. Protein of seeds:		
X5 Available -P (ppm)	86.00	X1 Bulk density, g/cm3
X2 Total porosity %	87.58	X3 Field capacity % X4 O.M. %
The best prediction equation: Y=3.8641+0.244X2+0.8903X5		
Relative contribution for all variables R2%=89.29%		

3.2. Seed yield:

The direct variables of seed yield are field capacity (X3) and bulk density (X1); these parameters are responsible for 32.47% of the total seed yield variance, whereas all studied variables are responsible for 32.97%. The other three variables are indirect because of their insignificant contribution. The best predicted equation is Y = 16511.0105 - 6216.2955X1 - 166.9351X3, where Y is seed yield in Kgs/fed.

3.3. Protein in seeds:

The direct variables of protein content in seeds are the available-P (X5) and total porosity (X2); these parameters contributed to 87.58% of the total protein of seeds variance, whereas all variables were responsible for 82.29%. The other indirect three variables show insignificant contribution. The best predicted equation is: Y = -3.8641 + 0.244X2 + 0.8903X5, where Y is protein content in seeds.

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مساهمة بعض خواص التربة في التنبؤ بمحصول الحمص

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أقيمت تجربة حقلية على أراضى رسوبية بشندويل - مصر العليا لتقييم مدى مساهمة كل من الكثافة الظاهرية - المسامية الكلية - السعة الحقلية والمادة العضوية وكذلك محتوى التربة من الفوسفور الميسر فى محصول الحمص وذلك عند اضافة كل من السماد الفوسفاتى والسماد العضوى والجبس لهذه الأراضى .. ولقد اوضحت النتائج ان كل خواص التربة السابقة الذكر قد تأثرت ايجابيا باضافة المواد المذكورة - كما أوضحت النتائج ان السعة الحقلية كانت العامل المؤثر على محصول القش فى حين كانت السعة الحقلية والكثافة الظاهرية هى العاملان المؤثران على محصول الحبوب .. أما محتوى الحبوب من البروتين فلقد كانت العوامل المؤثرة هى الفوسفور الميسر والمسامية الكلية