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USE OF PRESSMUD AS A SOURCE OF PHOSPHORUS FOR CROP PRODUCTION

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Pressmud, a by-product of the sugar industry, was compared to triple super phosphate (TSP) as a source of phosphorus for crop production. Four levels of P_2O_5 (0, 40, 80 and 100 kg/ha) were applied from pressmud and TSP. Maize and wheat crops were grown during 1989 - 1991. Phosphorus from both sources was applied to maize at the start of the experiment in 1989, and the residual effects were studied on the following crops. Phosphorus levels from pressmud increased maize fodder yield with increasing levels of P, but P from TSP had no effect on yield. P levels from both sources increased wheat grain yield (2nd crop), while residual P levels from both sources did not affect the yield of succeeding crops. During the first year, TSP gave higher dry matter yield of maize fodder (2184 kg/ha) and wheat grain (3881 kg/ha) as compared to pressmud, which resulted in yield of 1998 kg/ha maize fodder and 3791 kg/ha wheat grain, respectively. In third crop (maize), pressmud gave better dry matter yield (6122 kg/ha) than TSP (5598 kg/ha). The yield of the 4th crop (wheat) from both the sources was almost equal, which also indicate the decreasing effect of TSP with time whereas the effect of pressmud was just reverse. It was concluded that pressmud can be used as a source of phosphorus for crop production for longer period of time.

Key words: Pressmud, Phosphorus, *Zea mays*, Wheat.

Introduction

The energy crisis has renewed the use of organic fertilizer, since crop production must be increased to meet the growing demand for food and fiber from an increasing population. At present, therefore, there is much interest, not only in using organic fertilizers, but in improving the quality of these fertilizers so that they will be economically competitive with inorganic fertilizers. The high prices of synthetic fertilizers and the acute shortage of organic manures has drawn attention to the need for other sources. The problem is particularly serious, because Pakistan is situated in an arid to semi-arid region, and the majority of soils are low in organic matter because of high temperature during summers. Considering these factors, there is a need to utilize all types of organic matter available as a source of plant nutrients and also as a soil conditioner.

Pressmud (PM), a by-product of the sugar industry which contains not only the nutrients being removed from the soil by plants, but also the essential plant nutrients like P, Ca and S which are added during the boiling process inside the factory. In developed countries, PM is used as an organic manure [1] with significant beneficial effect on yield. Application of PM has been reported to decrease sodium absorption ratio (SAR), the result being an increase in infiltration rate and an increase in yields of cotton, wheat sorghum, maize, alfalfa and clover [2]. Addition of organic matter has been shown to reduce chemical fixation of P [3] and other work has demonstrated that recovery of soil P may be increased by mixing single super phosphate (SSP) with farm yard manure (FYM) Sarir *et al.* [4]. Kapur and Kanwar [5] reported a long-term increase in availability of P following PM application. In Pakistan, a major portion of PM is sold to the brick baking industry, causing a loss of plant nutrients and environmental pollution. Very little information is available regarding field application of PM and its effect on crop production. The present study was designed to provide such information.

Materials and Methods

Fresh pressmud was collected from Shakar Ganj Sugar Mills, Jhang and was dried in the sun. EC and pH of PM was determined by making paste (1:5, PM to water ratio). Total N by digesting the material with H_2SO_4 [6]. Dried PM samples were digested in $HClO_4$ - HNO_3 - H_2SO_4 mixture and P was analysed by colorimetrically [7] and K by flame photometer. Mineral matter determined by dry ashing the PM in furnace and organic matter was then calculated by difference. The chemical composition of the dried PM is given in Table 1b. Soil samples from the field were collected before the application of treatments and analysed for some chemical properties according to the methods described by Page *et.al.* [8] (Table 1a).

A long-term field trial was established during 1989 at Ayub Agricultural Research Institute, Faisalabad. Four doses of P (0, 40, 80 and 100 kg P_2O_5/ha) were applied to maize using two sources, i.e. Pressmud and tripple super phosphate. The quantity of pressmud added was calculated on an oven-dry basis. (Table 1c). Soil samples were collected and analysed for extractable P after 15 days of treatment application (Table 1c). Basal dose of N and K was applied to each crop at the rate of 120 kg N/ha and 60 kg K_2O/ha for maize and wheat crops as urea and potassium sulphate. The N and K contributed by PM is compensated by adding less N and K in plots receiving PM for the first crop (maize), while the other minor constituents in PM like micronutrients, Ca, Mg and S was considered as non-significant contributor in increasing the yield because the soil used for experiment is calcareous in nature. Treatments were replicated four times in a split-plot design by keeping the sources in the main plots and P levels in the sub plots.

Residual effects of these treatments were studied on succeeding crops of wheat, maize and wheat. Maize was the first crop sown in August 1989. Soil samples after the harvesting of each crop were collected and analysed for extractable P. Treatment means were tested using DMR test.

Results and Discussion

Analysis of soil samples taken after application of PM and TSP showed that plots receiving P from TSP had higher extractable P than did those treated with PM. Similarly P levels from TSP gave significantly higher maize fodder yields upto 80 kg P/ha, whereas at 100 kg P/ha level there was no significant difference between the two treatments (Table 2). This finding is not surprising in view of the evidence that crop response to P is rare beyond 10 ppm [9]. In this study, this concentration was achieved by adding 40 kg P/ha as TSP and no increase in yield was observed when TSP was applied at higher rates. In contrast, a yield increase from PM was obtained even at the highest rate of application where the level of extractable P was 9.3 ppm. It seems that crop response becomes uncertain at about 10 ppm extractable P. Comparing the two sources of P (TSP and PM), TSP released more P than did PM and proved to be a more effective fertilizer for maize fodder at this stage (Table 2).

After harvesting maize, wheat was planted on the same plots to determine the residual effects of the two sources of P. The grain yield data are presented in Table 3. The trend for wheat grain is very similar to that of the previous maize crop, but soil P levels were just opposite. There was a response to added P, with TSP as a source of P giving significantly higher yield than did PM, but P levels in soil did not support the results. This discrepancy could have arisen if chemical extraction removed more P from the soil rich in organic matter (OM), whereas biological extraction i.e. by crop roots was more effective in removing P under conditions where the content of organic matter was lower.

Data presented in Table 4 show the residual effect of P on the third crop (maize fodder). There was no significant effect of P either within or between sources (TSP and PM) of P. The initial heavy doses of P applied from TSP increased the yields of the first and 2nd crops, but had no effect on the third crop. Similar finding have also been reported previously by Ruhal and Deo [10].

Pressmud treated plots showed better residual effect than

TABLE 1 (a). CHEMICAL CHARACTERISTICS OF SOIL USED FOR PRESSMUD EXPERIMENT.

EC (dS/m)	pH	Total N (%)	Olsen P (μg/g)	Ext. K (μg/g)	OM (%)
1.81	8.1	0.05	3.4	330	0.74

TABLE 1 (b). CHEMICAL PROPERTIES OF PRESSMUD USED IN EXPERIMENT.

EC(dS/m) (1:5)	pH (1:5)	Total N (%)	Total P (%)	Total K (%)	OM (%)
6.2	5.9	1.52	1.18	0.68	78.5

TABLE 1(c). QUANTITY OF PRESSMUD AND TSP APPLIED IN FIELD.

P-applied (P_2O_5) kg/ha	Quantity of dry PM kg/ha	Olsen-P in soil μg/g	Quantity of TSP kg/ha	Olsen-P in soil μg/g
0	0	3.4	0	3.4
40	1480	5.5	87	10.7
80	2960	6.7	174	16.3
100	3700	9.3	217	22.4

P_2O_5 in TSP and pressmud is 46 and 2.7 % respectively.

TABLE 2. COMPARATIVE EFFECT OF PRESSMUD AND TRIPLE SUPER PHOSPHATE ON MAIZE FODDER YIELD (FIRST CROP).

Phosphorus	Olsen-P from soil		Fodder yield (dry matter)		
	PM	TSP	PM	TSP	Mean
kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha
0	3.4	3.4	1734 c	1734 c	1734 c
40	5.5	10.7	1908 bc	2358 a	2133 b
80	6.7	16.3	2039 b	2288 a	2164 ab
100	9.3	22.4	2309 a	2358 a	2334 a
Source mean			1998 b	2184 a	–

Treatment means of respective comparisons (interactions, levels and sources) sharing same letter do not different significantly at 5% probability level.

TABLE 3. COMPARATIVE RESIDUAL EFFECT OF PRESSMUD AND TRIPLE SUPER PHOSPHATE ON WHEAT GRAIN (2ND CROP)

Phosphorus	Olsen-P from soil		Grain yield		
	PM	TSP	PM	TSP	Mean
kg/ha	μg/g	μg/g	kg/ha	kg/ha	kg/ha
0	2.8	2.8	3520 d	3520 d	3520 C
40	6.0	1.6	3700 c	3906 b	3803 B
80	7.2	2.0	3897 b	4029 ab	3962 A
100	9.2	2.7	4048 a	4071 ab	4060 A
Source mean			3791 B	3881 A	

Treatment means of respective comparisons (interactions, levels and sources) sharing same letter do not different significantly at 5% probability level.

TSP, which was just the reverse of the effects on the first crop (Table 2). The difference perhaps was due to a slow and continuous release of P from pressmud in addition to other nutrients (N, K and Ca + Mg) and the contribution of organic matter, which improves the soil conditions and enhance the availability of other essential nutrients to the plants, as the available P in pressmud treated plots exceeded that in TSP-treated plots (Table 4). The low concentrations of soil P with TSP are consistent with the yield results and suggest that readily available P from this source had been utilized by the previous two crops (Table 4). Kapur and Kanwar [5] reported higher yields and P availability in the second and third year following the application of PM.

Wheat was sown as the fourth crop after maize in the same plots to further study the residual effects of PM and TSP. The P from PM increased yield with increasing levels of P, but residual P from TSP had no effect on wheat grain yield. Highest yield was obtained with the check plot, which may be attributed to nutrient depletion from the higher yields of the previous crops in fertilized plots Table 5.

Triple super phosphate proved more effective than PM in the first two crops (maize and wheat) by giving 9.3 and 2.4% increase over PM. Later on the residual effect of PM was more pronounced than that of TSP giving 9.4% more maize fodder yield and 1.5% more in case of wheat grain (Table 6). With time, the efficiency of TSP decreased, whereas, it increased with PM.

TABLE 4. COMPARATIVE RESIDUAL EFFECT OF PRESSMUD AND TRIPLE SUPER PHOSPHATE ON MAIZE FODDER YIELD (3RD CROP).

Phosphorus kg/ha	Olsen-P from soil PM µg/g	Olsen-P from soil TSP µg/g	Fodder yield (dry matter) PM kg/ha	Fodder yield (dry matter) TSP kg/ha	Fodder yield (dry matter) Mean kg/ha
0	2.6	2.6	5426 a	5426 a	5426 B
40	5.4	1.7	6225 a	5708 a	5967 A
80	5.7	2.0	6482 a	5607 a	6045 A
100	6.2	2.0	6356 a	5651 a	6004 A
Source mean			6122 A	5598 B	–

Treatment means of respective comparisons (interactions, levels and sources) sharing same letter do not differ significantly at 5% probability level.

TABLE 5. COMPARATIVE RESIDUAL EFFECT OF PRESSMUD AND TRIPLE SUPER PHOSPHATE ON WHEAT GRAIN (4RTH CROP).

Phosphorus kg/ha	Olsen-P from soil PM µg/g	Olsen-P from soil TSP µg/g	Grain yield PM kg/ha	Grain yield TSP kg/ha	Grain yield Mean kg/ha
0	2.5	2.5	2690 a	2690 a	2690 A
40	5.7	1.8	2333 c	2641 ab	2487 B
80	5.8	2.1	2432 bc	2273 c	2353 B
100	6.9	2.4	2674 ab	2377 c	2506 B
Source mean			2532 A	2495 A	–

Treatment means of respective comparisons (interactions, levels and sources) sharing same letter do not differ significantly at 5% probability level.

TABLE 6. COMPARATIVE EFFICIENCY OF PRESSMUD AND TRIPLE SUPER PHOSPHATE AS PHOSPHORUS SOURCES.

Year	Crop	PM kg/ha	TSP kg/ha	Percent increase over PM	Percent increase over TSP
1989	Maize fodder	1998	2184	9.3	=
1989-90	Wheat grain	3791	3881	2.4	=
1990	Maize fodder	6122	5598	=	9.4
1990-91	Wheat grain	2532	2495	=	1.5

Conclusion

Triple super phosphate proved a better source of P for the first two crops, but its effectiveness decreased gradually with time, however, increased in case of pressmud. After the second crop (wheat), the residual effect of pressmud exceeded that of for the 3rd (maize) and 4th (wheat) crops. In general lower yields of the fourth crop with both the treatments (TSP and PM) as compared to the control showed the depletion of P, probably alongiwth other nutrients, due to the initially higher yields obtained after the addition of P.

In reality, PM cannot be directly compared with TSP as a source of fertilizer P, because unlike TSP, PM contains other nutrients besides P and supply organic matter, which improves the chemical as well as physical conditions of the soil. For these reasons, PM has considerable potential as an organic fertilizer for sustainable agriculture and perhaps could proved better if both applied together in the field.

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