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Effect of Intensive Cropping and Fertilizer use on Organic and Inorganic Forms of Phosphorus in an Alluvial Soil.

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Intensive and continuous cropping on an alluvial soil resulted in less depletion of inorganic P (13%) and more of organic P (45%) Nitrogen applied alone has shown similar effect on these forms. Regular additions of inorganic P increased both inorganic (35.5%) and organic (90.0%) forms and farm yard manure applied in conjunction with optimum NPK dressing further enhanced the organic P. Progressive improvement in organic as well as inorganic form was manifested with the rise in graded doses of NPK Cultivation without application of phosphorus widened the C · org. P ratio but the ratio got narrowed in all the treatments containing optimum or higher doses of P.

Until recently, not much attention has been given towards critically examining how the high intensity of cropping with heavy doses of fertilizers would influence the fertility status of soil. Continuous cropping without addition of phosphate resulted in depletion of organic phosphorus reserves when compared to virgin or fallow soil (Williams and Lipsett, 1961; Greb and Olsen 1967). Several workers (Manning and Salomon, 1965; Omotoso, 1972) found that manures and fertilizers generally raised the level of inorganic P with little effect on organic P. However systematic application of dung or an equvialent rate of NPK or a combination of both to a rotation for 50 years was found to increase the organic P in a chernozem soil (Kudzin and Gubenko, 1968).

Results from some long term trails in India showed that chemical fertilizers increased inorganic form of P and farm yard manure built up the organic form (Kanwar and Prihar, 1952; Anjaneyulu and Omanwar, 1979; Zahate *et al.* 1979). In view of this, an investigation was made to study the effect of continuous multiple cropping and soil test based fertilizer use on inorganic and organic forms of phosphorus in an alluvial soil.

MATERIAL AND METHODS

The field experiment at the Indian Agricultural Research Institute, New Delhi pertaining to the present investigation was started in the *rabi* (winter) 1971-72. The annual crop rotation was pearl millet, wheat and cowpea (fodder) in sequence. The experiment was laid out in a randomized block design (10 x 4), the plot size being 21m x 8m. The following were the treatments included in the study.

1. 50 per cent of the reccomended optimum NPK fertilizer dose as scheduled on the basis of soil tests.

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2. 100 per cent of the recommended optimum NPK.
3. 150 per cent of the recommended optimum NPK.
4. 100 per cent of the optimum NPK as in (2) and hand weeding.
5. 100 per cent of the optimum NPK as in (2) and 10 kg. Zn So_4. 7 H_2O per ha. applied once in a year to wheat.
6. N and P (100%) as in (2).
7. N alone (100%) as in (2).
8. 100 per cent NPK as in (2) plus 15 tonnes of farm yard manure per ha. applied once in a year to pearl millet.
9. 100 per cent NPK as in (2) but with sulphur bearing source (super phosphate).
10. Control (without manure or fertilizer).

100 per cent optimum N, P_2O_5 and K_2O dose in kg/ha was 20 : 40 : 20 to cowpea and 120 : 60 : 40 to pearl millet and wheat. Urea, diammonium, phosphate and muriate of Potash were the sources of nutrients supplied. Irrigations were given as per the requirements of the individual crops in the rotation. Recommended chemical weed control measures were taken up in case of wheat and pearl millet to all the plots except hand weeding (T. No. 4).

Soil samples were collected before laying out the field experiment in November 1971 and later in May 1978 after the harvest of wheat. Four representative soil samples were also drawn from an adjacent fallow land in 1978. The initial characteristics of the surface soil (0.15 cm) from the experimental area were determnied (Jackson, 1958) and the important characteristics are sandy loam texture (sand 69%, silt 16%. clay 15%), very little free calcium carbonate (0.85%), Low CEC (10.6 me/100 g), slightly alkaline soil reaction (pH 8.0) and low soluble salt content (0.45 mmhos/cm at 25° C). The contents of, exchangeable calcium, magnesium and potassium were 7.4. 1.7 and 0.21 me/100 g respectively. The initial status of organic carbon, total N and total P were 0.443, 0.064 and 0.036 per cent respectively. Inorganic and organic P were estimated as per the ignition method suggested by Legg and Black (1955). Total Phosphorus was determined in di-acid digest by vanadomolybdic yellow colour method (Hesse, 1971).

RESULTS AND DISCUSSION

The results concerning total inorganic P determined by ignition method and organic P obtained by deducting inorganic P from the total P (ignition) have been given in table 1. For the sake of comparison, the total P estimated by perchloric acid digestion has also been presented. The data indicated that the procedure based on ignition has underestimated the total P to some extent as compared to perchloric acid digestion.

Both organic and inorganic P levels declined due to seven years of intensive cropping without any fertilizer addition when judged with their levels in an adjacent fallow. The extent of shortfall in inorganic, organic and total P (perch-

loric acid) was 13.1, 44.7. and 16.2 per cent respectively. When nitrogen was applied alone, all the forms got appreciably reduced but their contents were not significantly different from control plots. Several workers (Williams and Lipsett, 1961; Greb and Olsen, 1967) have reported that there was greater reduction in organic form than in inorganic form under continuous cropping without phosphate manuring. This could be due to greater mineralization of organic P and its subsequent uptake by the crop or fixation in inorganic form.

Seven years application of inorganic phosphate (diammonium phosphate or single superphosphate) significantly enhanced the status of organic, inorganic and total P. In contrast to the findings of some earlier workers (Kanwar and Prihar, 1962; Anjaneyulu and Omanwar, 1979) the phosphate additions have substantially improved the status of organic P (90.0%) in addition to inorganic (35.5%) and total P (50.0%). Intensive cropping with irrigation and fertilizer practices returns lot of organic residues to the soil and also creates favourable temperature and moisture regimes for the microbial activity. These could be the contributing factors for greater immobilization of phosphate in organic form.

Farm yeard manure contributed significantly towards organic P level, the recorded increase over optimum NPK being 22.4% and there was corresponding rise in total P (6.5%) content as well. Similar observations were made by Kanwar and Prihar (1962) and Zahate *et al*, (1979). Additions of sulphur and zinc did not seem to effect the status of either organic or inorganic form of phosphorus.

All the three graded doses of NPK viz,, 50, 100 and 150 per cent progressively and significantly raised the contents of organic, inorganic and total P in soil (Kudzin and Gubenko, 1968).

The C/org. P ratios ranged from 23.9 (NPK + FYM) to 92.0 (N alone) in different treatments (Table 1.) Under continuous and unmanured cropping the C; org. P ratio got widened as compared to fallow. This could be due to greater mineralization of organic P and its uptake by crops with nitrogen incorporations (Tan *et al.*' 1970) The ratio was lowered, in all the treatments containing optimum or higher doses of P (NPK + FYM, 150% NPK). The study thus reveals that under intensive and continuous cropping, the organic P shows greater intensity of change as compared to inorganic form.

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TABLE-1. Effect of various treatments on inorganic and organic froms of phospherus and C : ORC, P ratio (After seven years of cropping).

Treatment	Inorganic P (Ignition) Kg/ha	Organic P (ignition) Kg/ha	(Total) (Ignition) Kg/ha	Perchloric acid Kg/ha	C/Org, P ratio.
50% NPK (Soiltest)	635	224	859	950	44.0
100% NPK (ST)	801	419	1220	1235	28.9
150% NPK (ST)	875	515	1390	1404	24.4
100% NPK & hand weeding	789	353	1142	1218	31.4
100% NPK plus 10 kg Zn so_4/ha	801	394	1195	1234	28.9
100% NP	789	406	1195	1202	26.3
100% N	493	106	599	637	92.0
100% NPK Puls 15 tonnes FYM	838	513	1351	1316	23.9
100% NPK with sulphur source	776	420	1196	1249	26.3
Control (No fertilizer)	506	119	625	671	56.7
S. Em (+)	22.2	28.1	20.7	25.0	–
C. D. at 5% level	64	81	60	72	–
Fallow Status	582	215	797	801	49.0