

Effect of phosphorus on the Yield and Composition of Green Manure and Availability of organic phosphorus in paddy soils *

by

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Synopsis: Sunnhemp was grown in pots containing paddy soils from Mankhanda, Raipur, Karjat and Titabar with and without the application of tagged super phosphate. The green manure was cut after 15 days and applied to the soils maintaining equal phosphorus level. The soils were analysed after 18 days incubation at the laboratory temperature and conclusions drawn regarding the comparative merits of applying phosphorus through green manure and direct application to paddy soils.

Introduction: Beneficial effects of phosphatic fertilizer on the growth of green manure and also the availability of the phosphorus contained in it have been reported by Parr and Sen (1948), Venkatarao and Govindarajan (1952), Khan and Mathur (1953), Shende and Sen (1958), Panos (1959), Raheja (1961) and Singh (1961). But Krishna Rao *et al.* (1962) did not find any special benefit by the application of phosphate to the green manure crop intended for paddy. Similarly, the experiments sponsored by the Indian Council of Agricultural Research and conducted in the Madras State from 1958 to 1963 did not indicate any beneficial effect due to the application of phosphate to the green manure crops on paddy soils.

In view of the conflicting results it was thought of interest to investigate the uptake of fertilizer phosphorus by the green manure crop using P^{32} and assess its availability in some of the paddy soils of India.

Materials and Methods: Four samples of paddy soils taken from the surface layer (0—6") from Mankhanda (W. Bengal), Raipur (Madhya Pradesh), Karjat (Maharashtra) and Titabar (Assam) were used for the pot culture studies. For studying the uptake of fertilizer phosphorus by green manure, 1.90 kg. of the soil was put into small glazed pots. One set of the pots served as control, while another set of pots had soil mixed with tagged (P^{32}) super phosphate at the rate of 44.8 kg. per hectare. The treatments were replicated four times. Healthy sunnhemp seeds were sown in the pots at the rate of ten seeds per pot and watered as found necessary. Due to lack of time, the plants were allowed to grow for only 15 days and then cut and weighed. The plants were dried in an air oven

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and the dry weights recorded. As the yield of dry matter from the individual pots was small, the materials from the replications were mixed for studying the availability of phosphorus of the green manure and the experiment carried out as follows :

Two hundred gram samples of each of the four soils were taken in glass bottles of one pound capacity and given the following treatments :

- (a) Soil *plus* 0.020 gm. tagged super (with an activity of 0.2 mc. per gram of P) *plus* 0.200 gm. of dry sunnhemp from no phosphorus pot.
- (b) Soil *plus* 0.02 gm. of ordinary super *plus* 0.200 gm. of dry sunnhemp fertilized with tagged super.
- (c) Soil *plus* 0.02 gm. of tagged super only.

In each case the soil was well puddled and mixed with the green manure and super phosphate. The soils were then incubated at room temperature. Soil samples were drawn from the bottles at the end of 18 days, dried and extracted with Bray's No I extractant and the available P determined colorimetrically.

The original soils were analysed for the following :

1. Moisture ... (Piper 1950)
2. Organic carbon ... (Walkley and Black 1934 as modified by Walkley 1935)
3. Total Nitrogen ... A. O. A. C. (1955)
4. Available phosphorus ... Bray's method (No I solution Bray and Kurtz 1945)
5. Total phosphorus ... Colorimetrically by the vanadomolybdate method in the hydrochloric acid extract of the soil after reduction with Jones reductor (Jackson 1958)
6. pH ... (Piper 1950)
7. Electrical conductivity ... (in the 1 : 2 extract with a solu bridge)

The sunnhemp plants were analysed for total P by the vanadomolybdate method (Koeing and Johnson 1942) and radioactive P by the method of Mackenzie and Dean (1948).

Results and Discussion : The initial analysis of the soils is given in Table I. The yield of sunnhemp is given in Table II. The radio chemical

analysis of the sunnhemp plant and the nitrogen and phosphorus uptake by the plants are given in Table III. The available phosphorus in the soils after 18 days of incubation is given in Table IV.

TABLE I.
Analysis of Soils. (Oven-dry basis).

Head of Analysis	Mankhanda	Raipur	Karjat	Titabar
Moisture %	2.92	4.29	5.62	2.28
Organic carbon %	1.38	1.00	1.08	1.78
Total Nitrogen %	0.055	0.025	0.047	0.104
Total Phosphorus %	0.38	0.21	0.58	0.27
Available Phosphorus (ppm.)	90.7	14.6	78.4	40.9
pH	6.0	6.8	7.1	4.5
Electrical conductivity @ 25°C m. mhos/cm.	1.4	0.3	0.3	0.25
Texture	Clay	Clay	Sandy loam	Clay loam

TABLE II.
Yield of Sunnhemp (15 days' growth). (Wet weight in gm.)

Name of soil	Mean yield per pot	
	Without P	With P
Mankhanda	3.62	4.11
Raipur	4.44	4.67
Karjat	5.34	5.57
Titabar	3.85	4.01

Between	S. E. of mean	C. D. (P = 0.05)
(a) Soils	0.0967	0.2829
(b) Treatments	Not significant	
(c) Interaction	Not significant	

Conclusion :	Karjat, Raipur	Titabar Mankhanda
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TABLE III

Composition and Uptake of N and P by Sunnhemp.

Soil and Treatment	Percentage of total		Yield of sunnhemp (dry weight) in gm. per pot	Uptake of P by sunnhemp in milligram per pot.	Uptake of N in milli-gram per pot
	Nitro-gen	Phos-phorus			
Mankhanda Control	5.13	0.39	0.385	1.49	19.75
do Treated	4.73	0.37	0.480	1.79	22.71
Raipur Control	5.71	0.37	0.475	1.78	27.12
do Treated	4.71	0.34	0.480	1.50	22.60
Karjat Control	4.98	0.31	0.588	1.83	29.28
do Treated	5.64	0.36	0.600	2.18	33.85
Titabar Control	5.46	0.37	0.398	1.47	21.73
do Treated	5.67	0.45	0.425	1.92	24.10

Uptake of Fertilizer Phosphorus by Sunnhemp.

Name of Soil	Specific activities of sunnhemp & fertilizer	Percentage of P from fertiliser in sunnhemp	Percentage of utilization of added P in the fertilizer	Remarks
Mankhanda	5.66	4.68	0.56	Sunnhemp grown after application of tagged super.
Raipur	20.39	16.85	1.68	
Karjat	3.50	2.89	0.42	
Titabar	21.24	17.55	2.23	
(Tagged Super Phosphate)	120.95			

TABLE IV

Available Phosphorus in the incubated paddy soil in parts per million, (Oven-dry basis)

Soil	Treatment	Available P (ppm) in the incubated soil after 18 days	Percentage of the extractable P in the incubated soil after 18 days to the total of soil and applied P
Mankhanda	a	60.7	58.09
	b	69.9	67.81
	c	74.1	73.81

TABLE IV (Contd.)

Soil	Treatment	Available P (ppm) in the <i>incubated soil</i> after 18 days	Percentage of the extractable P in the incubated soil after 18 days to the total of soil and applied P
Raipur	a	8.4	29.54
	b	4.3	20.38
	c	21.7	88.55
Karjat	a	76.6	83.60
	b	94.6	103.90
	c	100.3	116.90
Titabar	a	84.5	155.30
	b	69.5	128.60
	c	69.5	137.60

Note: a, b, c, denote treatments as given above.

As may be seen from Table II, the application of phosphorus to the soil has given rise to a slight increase in the yield of green manure which is, however, not statistically significant. This is in agreement with the results obtained with sesbania at Coimbatore and daincha at Tirurkuppam in the Indian Council of Agricultural Research Experiments on the uptake of phosphates through leguminous plants (Unpublished results 1958—'63). But the differences due to soil are highly significant. A scrutiny of the yield, initial chemical analysis and the texture of the soils suggests that the yield is possibly correlated with pH and is also influenced by the texture on the soil. Thus the soil from Karjat which is having a pH of 7.1 and is sandy loam in texture has given the highest yield followed by Raipur soil which is having a pH of 6.8 and is clayey in texture. The soil from Mankhanda and Titabar which are acidic in reaction and clayey in texture have given lower yields than the soils mentioned above.

As regards the composition of the sunnhemp plant, the application of phosphorus to the soil has raised the percentage of P in the case of plants grown on Titabar and Karjat soils while the differences are in favour of no phosphorus in the other two soils. The variations in the nitrogen percentage in the plants run parallel to those of phosphorus.

When the uptake of phosphorus by the plants is calculated, larger amounts are found to have been removed from phosphorus treated soils of Karjat, Titabar and Mankhanda than from no phosphorus soil. Nitrogen uptake also followed the same pattern.

As regards the utilization of fertilizer phosphorus, sunnhemp grown on Titabar soil gives the maximum value followed by the plants raised on Raipur soil, while the plants grown on Mankhanda and Karjat record lower values which are nearly the same. A comparison of the values with the chemical analysis of the soils indicates that the percentage of utilization of the fertilizer phosphorus by the plant is inversely proportional to the available phosphorus of the soil as extracted by Bray No. I solution.

The radio chemical analysis of the soils after 11 days of incubation did not indicate any radio activity in the Bray No. I solution extract. Hence, the figures are not given for the same.

The analysis of the soils after 18 days of incubation (Table No. IV) indicates that the available phosphorus is generally higher in the case of Titabar and Karjat soils and lower in the case Mankhanda and Raipur than in the beginning.

As regards the difference between the treatments, the figures indicate that indirect method of applying phosphorus through green manure is better than the direct method in the case of Mankhanda and Karjat soils and the reverse in the other two soils.

Since the Mankhanda and Karjat soils had comparatively higher amounts of available phosphorus initially than the other two soils, the results indicate that the indirect method of applying phosphorus through green manure is better in soils having initially higher amounts of available phosphorus while the direct application of phosphorus is better in the case of soils of low available phosphorus.

Summary and Conclusions: With a view to compare the relative efficiency of direct application of phosphorus to paddy soil through fertilization of green manure, pot culture experiments were carried out with soils from Mankhanda (West Bengal), Raipur (Madhya Pradesh), Karjat (Maharashtra) and Titabar (Assam). Sunnhemp was grown as green manure on them with and without application of tagged super phosphate. The plants were cut after 15 days growth and incorporated into the soil as indicated below:

- (a) Soil *plus* green manure from no phosphorus treatment *plus* tagged super

- (b) Soil plus green manure fertilized with tagged super plus ordinary super
- (c) Soil plus tagged super only.

The soil was kept puddled up to 18 days and then analysed.

The following conclusions are drawn :

1. The yield of sunnhemp depends on the pH and texture of the soil
2. The application of phosphorus has not given significantly higher yield of green manure
3. The uptake of phosphorus and nitrogen is parallel in the green manure and has been generally greater in the phosphate treatment
4. The utilization of fertilizer phosphorus by the green manure is more in soils with lower amounts of available phosphorus
5. Between the two methods of application of phosphorus to paddy soil, indirect method of application through green manure is beneficial in soils with higher amounts of native available phosphorus while direct application is better in the soils containing lower amounts of available P.

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