https://doi.org/10.29321/MAJ.10.A03609

P. Distribution in Black and Red Soils of U. P.

by

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Introduction: Large tracts of red and black soils occur towards the South-east region of U. P. in Vindhyan range. As the demand for more food is increasing, these soil areas will have to be put under plough and in order to get more yield per acre a definite manuring schedule will have to be adopted.

Before phosphate can be added to these soils, it will be necessary to have a first hand knowledge regarding phosphorus potentialities of these soils. Phosphorus exists in combination with Ca, Fe, Al and organic fraction of soils. Accordingly such forms as Ca-P, Fe-P, Al-P and organic bound P have been differentiated. For chemical characterization of soil phosphorus, a fractionation of soil phosphorus is necessary because the chemical nature of each form of soil phosphorus is a factor which determines their relative effectiveness for crop growth.

A number of techniques for soil P fractionation have been advocated by different workers from time to time (Dean 1938 Ghani 1943, Bray and Dickman 1941, Williams 1950, Chang and Jackson (1957), Kanwar (1959) fractionated some Punjab soils for their soil phosphorus by William's technique and he found that acid soils contain more P in iron and aluminium combinations and that three fourth of total P exists in calcium combination. Goel and Agarwal 1959, studied the forms of soil phosphorus in Gangetic alluviul soils. They observed that P in Fe and Al combination increases with soil maturity at the expense of calcium bound phosphorus. Patel and Mehta (1961) fractionated soil phosphorus of some Gujarat soils and found that adsorbed P and Ca-P gave a significant correlation with the uptake of phosphorus by *sorghum* plants. Bapat *et al.* (1965) found a significant correlation between available and calcium bound phosphorus in calcareous soils and between Al and Fe bound P in other soils, while fractionating Vidarbha soils for their soil phosphorus.

The present study was undertaken with a view to evaluate the pattern of distribution of different forms of phosphorus originally present in some black and red soils of U. P. Such a study may prove useful in giving information regarding the fraction or fractions which are related to the availability of phosphorus in soils.

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Materials and Methods: The samples of red soil were collected from Mirzapur district whilst samples of black soils were collected from Allahabad, Ballia and Mirzapur districts. The surface samples were collected from the surface 15 cm layer. The profiiles were dug upto different depth in different regions.

After bringing the soil samples in the laboratory, they were dried, powdered and passed through a 100 mesh sieve and then were analysed for their sesquioxides (R_2O_3), $CaCO_3$, phosphorus and organic carbon contents. pH of the soils was determined by Leeds Northurp pH meter. Some of the important constituents of surface samples and profiles are reported in table I (a and b).

Phosphorus in leachates and solutions was determined colorimetrically using sulphomolybdic acid and chlorostannous reagents. Total phosphate was determined by sodium carbonate fusion method (Jackson 1962). Complete fractionation of native soil phosphorus was performed according to the procedure given by Chang and Jackson (1958). Organic phosphorus was determined by the method of Mehta *et al.* (1954). Available phosphorus in soil samples was estimated using Olsen's 0.5M $NaHCO_3$ method. Organic carbon was determined by Walkley and Black's rapid titration method. Sesquioxides were determined in HC1 extracts (Piper 1944).

For the fractionation of native phosphorus in soil, 1 g of soil sample was used. First of all A1-P was extracted by NH_4F, then Fe-P by NaOH and finally Ca-P by H_2SO_4 treatment. The amount of phosphate present in different fractions has been reported as mg of P per 100 g of soil.

Results: *Distribution of P in surface samples of black and red soils:* From the data reported in table 2(a), it is observed that the total phosphorus is greater in surface samples of black soils than in red soils. There is a great variation in total P in black soil samples from Allahabad and least in Mirzapur. The available phosphorus constitutes 11.5 to 15.4% in surface samples of red soil and 5.4 to 13.8% of total P in the black soil samples. Thus a lesser % of total P is observed to be present in available form in black soil samples (black soil samples from Allahabad showing minimum values). Org-P in red soil samples varies from 15.7 to 26.7% of total P but in black soils it varies from 11.5 to 27.9%, a maximum % of Org-P being present in surface soil samples from Ballia and minimum in surface samples from Birha (Allahabad district). The total inorganic phosphorus (sum of A1-P, Fe-P and Ca-P) varies from 15.5 to 17.3% in surface samples of red soil and 33.8 to 59.9% in black soil surface samples. The surface samples of Allahabad soil mark both the maximum and minimum values of organic-P. It is further interesting to note that inorganic P and organic P are apptoximately equal

TABLE 1 (a). *Chemical composition of soils (surface samples)*

Soils	Sesquioxides %	$CaCO_3$ %	Org. Carbon %	pH
Red soil of Mirzapur				
1	5.30	0.87	0.76	6.4
2	8.60	0.84	0.92	8.2
3	9.60	0.42	0.70	7.0
Black soil of Ballia				
1	16.70	1.75	0.52	8.0
2	17.80	1.90	0.60	7.2
3	17.40	2.15	0.57	7.5
4	15.70	2.60	0.58	9.0
Black soil of Mirzapur				
1	17.90	2.50	0.48	8.3
2	23.74	2.60	0.43	8.3
3	18.85	2.40	0.45	8.3
4	22.15	2.05	0.39	8.0
Black soil of Allahabad				
1	19.34	1.37	0.33	7.2
2	20.88	1.50	0.27	7.3
3	17.70	1.60	0.49	6.8
4	14.12	1.45	0.58	6.9

TABLE 1 (b). *Chemical composition of soils (Profiles)*

Soil and depth in cm	Sesquioxides %	$CaCO_3$ %	Org. Carbon %	pH
Red soil of Mirzapur				
(Khantara)				
(0–12.5)	5.3	0.87	0.76	6.4
(12.5–55)	11.8	1.02	0.52	6.4
(55–82.5)	16.4	1.17	0.43	6.6
(82.5–150)	23.8	1.12	0.36	7.2
Black soil of Ballia				
(Peeperpanti)				
(0–17.5)	16.7	1.75	0.52	8.0
(17.5–73)	17.6	2t25	0.43	8.0
(73–150)	17.2	2.25	0.47	8.1
Black soil of Mirzapur				
(Gaipura)				
(0–10)	21.8	2.5	0.45	8.3
(10–47.5)	21.1	2.9	0.37	7.5
(47.5–82.5)	21.3	2.9	0.33	7.3
Black soil of Allahabad				
(Birha)				
(0–17.5)	17.9	1.25	0.21	7.4
(17.5–52.5)	17.3	1.75	0.24	7.3
(52.5–90)	17.7	2.75	0.36	8.2

TABLE 2 (a). *Forms of phosphate in surface soil samples and their interrelations with organic C, $CaCO_3$ and sesquioxides (Surface samples)*

Soils	Total	Inorg-P (mg P/100 g soil) Al-P	Fe-P	Ca-P	$\frac{\text{Inorg-P}}{T}\times 100$	Org-P (mg P 100 g soil)	$\frac{\text{Org-P}}{T}\times 100$	Avail-P (mg P/ 100 g soil)	$\frac{\text{Avail-P}}{T}\times 100$	$\frac{\text{Org-C}}{\text{Org-P}}$	$\frac{CaCO_3}{\text{Ca-P}}$	$\frac{\text{Sesquioxides}}{\text{Al-P+Fe-P}}$
Red Soil of Mirzapur												
1	27.75	0.75	2.0	2.0	17.16	6.7	24.3	4.29	15.4	112.5	435.0	1927
2	31.75	0.50	2.0	3.0	17.32	8.5	26.7	3.81	12.0	108.2	280.0	3444
3	33.75	0.75	3.0	1.5	15.55	5.3	15.7	3.89	11.5	132.0	280.0	2560
Black Soil of Ballia												
1	41.0	1.5	4.7	10.50	40.7	9.5	23.1	5.16	12.5	54.7	166.6	2693
2	53.0	2.0	6.7	11.75	38.5	11.9	22.4	4.76	8.9	50.4	161.7	2045
3	44.0	1.5	4.7	10.75	38.5	12.3	27.9	3.89	8.8	46.3	200.0	2806
4	47.5	1.5	3.2	13.25	37.7	12.7	26.9	3.39	8.2	45.4	196.2	5340
Black Soil of Mirzapur												
1	37.5	2.0	3.2	13.25	49.7	7.0	18.6	3.2	8.5	68.5	188.9	3443
2	36.2	2.5	4.5	12.25	53.1	5.2	14.3	3.7	10.2	82.6	212.2	3391
3	37.5	2.0	3.2	12.75	47.6	6.0	16.0	4.8	12.8	75.0	188.2	3625
4	40.0	3.0	5.7	8.75	43.6	6.0	15.0	5.0	12.6	65.0	234.2	2545
Black Soil of Allahabad												
1	32.50	0.75	2.5	7.75	33.8	5.3	16.3	3.16	9.72	62.0	177.4	5950
2	27.50	0.75	2.5	6.75	36.3	4.0	14.5	3.80	13.80	67.5	222.2	6424
3	56.25	5.75	8.0	17.25	55.9	6.5	11.5	3.04	5.40	75.3	92.7	1287
4	58.75	5.75	8.0	14.00	47.2	6.5	11.6	3.64	6.19	89.2	103.5	1026

T = Total P

in red soils whereas in black soils inorganic P is far greater than organic P. The ratio of Org-C/Org-P varies from 108.2 to 132 in red soil samples and 45.4 to 89.2 in black soil samples. Thus the ratio is much smaller in black soil in comparison to red soil samples. It shows that more of P is in combination with organic matter in black soil than red soils. The $CaCO_3$/Ca-P ratio varies from 280-435 in red soil and from 92.7 to 234.2 in black soil. Comparatively low values of the ratio in the case of black soil, in spite of higher $CaCO_3$ contents indicate that more of P is in Ca-combination in black soil than in red soil.

Distribution of P in soil profiles: From the perusal of the data in table 2(b), it is observed that there is a marked tendency for the total P to increase with depth in the red soil profile whereas it decreases in black soil profiles. The organic P decreases with depth in red soil profiles but there is very little change in the amount of organic P with depth in black soil profiles. The available P has a tendency to decrease with depth in all the profiles, however, a regular pattern is not observed. The Mirzapur and Allahabad profiles are in no way superior to red soil profiles in their available P contents. The available P, expressed as percentage of total P, varies from 9.0 to 15.4% in the red soil profile and 8.18 to 15.14% in the black soils. The inorganic phosphorus varies from 12.9 to 17.16% in red soil profile and 35.8 to 54.8% in black soil profiles. However, the differences in various horizons are not very marked. The Org-C/Org-P ratio is maximum at the top and has a tendency to decrease in red soil profile, however, in three black soil profiles out of four profiles (exception being Mirzapur profile) there is a tendency for the ratio to increase with depth. This ratio varies from 51 to 72 in case of black soil profile and it is above 100 in red soil profile. The low ratio in black soil profile indicates the presence of considerable amount of P in organic combination. $CaCO_3$/Ca-P ratios tend to increase upto a depth of 82.5 cm and then decrease in red soil. This is certainly due to an increase in amount of $CaCO_3$ with depth. There is also an increase in the ratio in case of black soil profiles with depth. But as there is an increase in $CaCO_3$ with depth, in these profiles also, the values of this ratio are lower (158.6 to 333.3 in comparison to red soils 435 to 783.3).

Fe-P and Al-P: The surface samples of both red and black soils have a greater amount of Fe-P than Al-P both in red and black soils. A similar trend is observed in profiles as well. The ratio of sesquioxides/Al–P+Fe–P is found to vary with depth in both red and black soil profiles, the values of the ratio being always higher for black soils than for red soil. Such a ratio points out to a prevalence of sesquioxides bound P in red soils than in black soils inspite of higher % of sesquioxide contents in black soils. The amount of Ca–P is higher than Al–P in case of block soil both in surface samples as

TABLE 2(b). *Forms of phosphate in soil profiles and their interrelations with organic C, $CaCO_3$ and sesquioxides*

Soils depth in cm	Total	Inorg.P (mg P/100 g soil) Al-P	Fe-P	Ca-P	$\frac{\text{Inorg-P}}{T} \times 100$	Org-P (mg P 100 g soil)	$\frac{\text{Org-P}}{T} \times 100$	Avail-P (mg P/ 100 g soil)	$\frac{\text{Avail-P}}{T} \times 100$	$\frac{\text{Org-C}}{\text{Org-P}}$	$\frac{CaCO_3}{\text{Ca-P}}$	$\frac{\text{Sesquioxides}}{\text{Al-P + Fe-P}}$
Red Soil of Mirzapur												
0–12.5	27.75	0.75	2.0	2.0	17.1	6.7	24.3	4.29	15.4	112.5	435.0	1927
12.5–55	29.25	0.75	1.8	1.7	14.7	5.0	17.0	3.33	11.3	104.0	585.7	4635
55–82.5	30.50	0.50	2.2	1.5	13.9	4.2	13.9	3.05	10.0	101.1	783.3	5963
82.5–150	37.90	1.00	2.0	1.9	12.9	3.5	9.2	3.53	9.0	102.8	592.1	7943
Black Soil of Ballia												
0–17.5	41.0	1.50	4.7	10.5	40.7	9.5	23.1	5.16	12.5	54.8	166.6	2693
17.5–73	39.2	1.00	3.5	9.7	35.8	8.0	20.4	4.56	11.5	54.3	237.7	3955
73–150	35.6	1.75	4.7	10.0	46.2	8.2	23.1	3.73	10.4	56.9	225.0	2651
Black Soil of Mirzapur												
0–10	37.5	2.0	3.2	13.2	49.7	7.0	18.6	3.20	8.52	64.2	188.60	4192
10–47.5	33.7	1.8	3.5	13.0	54.8	6.5	19.2	2.76	8.18	57.7	223.07	3981
47.5–82.5	35.0	1.2	3.0	13.3	50.0	6.4	18.4	4.16	11.88	51.0	218.04	5071
Black Soil of Allahabad												
0–17.5	23.75	0.50	1.5	7.2	38.8	4.0	16.8	3.24	13.60	52.5	158.6	8950
17.5–52.5	21.25	0.25	1.5	7.0	41.1	4.2	20.0	3.24	15.24	56.4	250.0	9971
52.5–90	23.75	0.15	1.5	8.2	41.6	5.0	21.5	3.44	14.48	72.0	333.3	10727

T = Total P

well as in samples of profile. The ratios between Al–P, Fe–P and Ca–P can be approximately written as 1:3:3 for red soil and 1:3.5:5.6 for black soils. Thus the black and red soils can be superficially differentiated in terms of Ca–P and Org–C/Org–P whilst only Org–C/Org–P can serve as criteria to differentiate the soils vertically.

Discussion: The black soils are initially better supplied with total P in comparison to the red soils of Eastern region of U. P. The distribution of various forms in which total P has been found to exist can be exalined by the following consideration:

1. *Increase of total P with depth:* Such an increase can be definitely ascribed to be due to leaching phenomenon which is progressive in soil profiles. As Vindhyan range area of U.P. is comparatively humid, leaching is intensive and it is evident from increased content of $CaCO_3$ and sesquioxide in lower horizons of red soil profile. The black soils too suffer a similar leaching but the exchange complex being absolutely saturated does not permit the leaching of phosphate.

2. *Decrease in organic-P with depth:* As organic carbon goes on decreasing with depth, organic P decreases, a maximum concentration of organic P at the top and in the surface samples is due to similar effects.

3. *Greater percent of organic P than available P in black soils:* The inorganic P represents Al–P, Fe–P and Ca–P and it is governed by the amounts of sesquioxides and $CaCO_3$ in various horizons. A greater percentage of inorganic P in case of black soil is definitely due to a large amount of $CaCO_3$ in its various horizons. A greater amount of Ca–P leads naturally to lower $CaCO_3$/Ca–P ratios in black soils and as $CaCO_3$ increases with depth, it also goes on increasing.

4. *Available phosphorus:* The values of available P in both black and red soils are low in comparison to the amounts of inorganic P, the values being more prominent in case of black soils. It indicates that the extractant (0.5M $NaHCO_3$) fails to extract phosphorus from Ca-combination and hence low values are obtained. It is supported from the Sesquioxides/Al–P and Fe-P values obtained for black and red soils wherein the ratios show definite trends in both black and red soils. The presence of greater amount of Fe–P than Al–P in both black and red soils is a further proof that of the sesquioxides, the Fe_2O_3 contents is of paramount importance in determining the distribution of phosphates in soils.

Thus organic matter, $CaCO_3$ and sesquioxides appear to be guiding factors in determining the distribution of organic–P, Ca–P, Al–P and Fe–P in red and black soil profiles of U. P. The distribution of various forms of P as well as total P in surface samples also obey the same principle.

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Adaptation of *Botryodiplodia theobromae* (Pat) Griff, ET.maubl to Salts and Its Importance in Agriculture*

by

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Introduction: The use of certain drugs particularly antibiotics against bacteria and certain insecticides against insects have resulted in the appearance of resistant strains, creating a new problem in the treatment of diseases. Unlike insects so far fungi do not seem to have reacted to fungicides in such a spectacular manner although a downy mildew resistance does occur against certain chemicals (Taylor 1953). Fungi have been reported to educate themselves to increasing concentrations of toxic substances (Wilson 1947 and Hirschhorn and Munneck 1950). In some cases mutation clearly accounted for what could have been considered adaptation while in other cases visible mutation did not account for such results. The present work was undertaken to study the adaptation of *Botryodiplodia theobromae* to copper sulphate, mercuric chloride and zinc sulphate.

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* Excerpts from the thesis submitted for the degree of M.Sc. (Ag.) (Plant Pathology) to Vikram University, 1961.

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