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Studies on uptake of natural radioactive nuclides from soil and health risk assessment on kharif crop rice *viz*., B-33, PR-131 & CR-212

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Abstract
In in the present manuscript field experiment on P^{32} tracer soil were conducted July 2023- December 2023 to assess the effect on the growth and phosphorus absorption in different part of rice *viz*., seedling, flowering and harvesting stages was studies in water culture, for which pot culture experiment was carried out with four levels of phosphorus using P^{32} tagged super phosphate *viz*., 0.0, 0.75, 1.50, 2.50, gm. P_2O_5/25 cm (Pot) and three varieties of crop rice *viz*., B-33, PR-131, CR-212 to study, respectively. A uniform doses of recommended N & K were applied along with uptake of utilization of applied fertilizer as P treatment in dark clay of Moradabad District, U.P. in India. An increase in the phosphorus of the absorbed phosphorus trans-located to the short and the reduction of root weight were the most consistent symptoms. Dry matter yield, total uptake of phosphorus and percentage of P^{32} derived from fertilizer increased significantly with increasing level of phosphorus. But % utilization of added phosphorus showed a reverse trend, at all the stages of crop growth. Harvesting (Grain and straw) yield increased significantly with increasing phosphorus levels in all three varieties of crop rice with their respective controls.

Keywords: Rice, N, P^{32} tracer, K, soil, fertilizer, seedling, root, flowering, and harvesting

Introduction
Dark clay is clay rich soil that shrink and swell with change in moisture content. During day periods the soil volume shrinks and deep vide cracks form. The Soil volume then expends as it gets wets up. The difficulty with phosphatic fertilizers is, when it is applied to black soil (Vertisols) a large function of its fixed (80-85%) in the soil and only small portion (15-20%) is available to the plant. In the present manuscript study was to investigate the comparative and combine effect of phosphorus on utilization with different varieties (*viz*., B-33, PR-131, CR-212) of rice at various stage of growth parameters (*viz*., seedling, flowering, harvesting stages) in a soil with their respective controls.

Experimental
The pot culture experiment was conducted during July2023-December 2023 in the department of chemistry, Hindu College, Moradabad with the varieties *viz*., B-33, PR-131, CR-212 of crop rice and four levels of phosphorus *viz*., 0.0, 0.75, 1.50, 2.50 gmP_2O_5/25 cm (pot), respectively. Soil sample were collected from experimental area and filled with 6.0 Kg soil capacity of 25 cm radius of earthen pots. The soil contained 0.6% organic carbon and 3.5 gm/pot (25 cm), 10% and 4.125 gm/Pot (25 cm) available N, P and K_2O, respectively. The pH of soil was 7.3. A basal application of 20% N and 25% K_2O was applied at the time of sowing. Urea, single superphosphate and muriate of potash was used as the source of N, P, and K, respectively. Rice varieties B-33, PR-131, CR-212 were selected as a treatment crop. Four level of phosphorus *viz*., 0.0, 0.75, 1.50, 2.50 gm P_2O_5/25 cm (pot) were used as a tagged superphosphate having specific activity of 0.40 mCi/gm P_2O_5 which was produced from Narora Power Station (NAPS) a nuclear power plant located in Narora, Dibai Tehsil, Bulandshahar District (U.P.) in India, coordinates $28^0$9" N$78^0$24'34''E, reactors-2, cooling source Naroda Barrage River Ganga and power generation in 418 M.W. It is situated 103 Km. south of Moradabad District. The waste material of the plant was collected from various places near the nuclear power plant. The radioactive phosphorus in plant materials was determined by the method given in Morel and Fardeau [1] counting for radioactive phosphorus was done by placing sample under identical conditions in G.M. Counter. The total P- uptake was determine by the methods of Singh and Murphy [2, 3] and growth parameters of the crop were statistically analyzed [4].

Results and Discussion

All results are shown in table (1-5). Table-1 reveals that the total phosphorus uptake increased significantly with increasing level of phosphorus at all the stages of growth in all varieties of crop rice with their respective controls these values are represented by bar diagram (fig. A). This might be due to the higher availability of phosphorus with increasing phosphorus level [5, 6].

Table 1: Effect P level on total P-uptake (mg/pot) by crop rice at different stages of growth parameters.

P levels gm P_2O_5/ 25 cm	Seedling Stage			Flowering Stage			Harvesting Stage		
	B-33	PR-131	CR-212	B-33	PR-131	CR-212	B-33	PR-131	CR-212
P_C	6.21	7.77	6.38	16.60	16.52	26.91	48.49	52.73	47.93
$P_{0.75}$	10.33	7.74	9.25	22.86	25.48	31.71	68.31	70.04	66.31
$P_{1.50}$	12.01	12.16	13.11	34.12	34.68	39.33	85.47	90.12	85.93
$P_{2.50}$	12.64	13.54	12.24	36.41	40.61	38.62	103.81	103.52	96.52
Mean ±SE	10.28±(0.02)	10.23±(0.02)	9.23 ±(0.1)	27.50±(0.20)	29.32±(0.12)	34.13±(0.03)	76.08 ±(0.21)	79.12 ±(0.35)	74.18 ±(0.30)
Effect	P		V	P		V	P		V
±Sem	0.33		0.34	0.48		0.36	0.47		0.16
F	364.342**		548.563**	1012.01***		1122.13***	948.53***		1351.52**
CD	0.26		NS	2.28		2.19	1.66		NS

**p<0.01, ***p<0.001 at 5% level

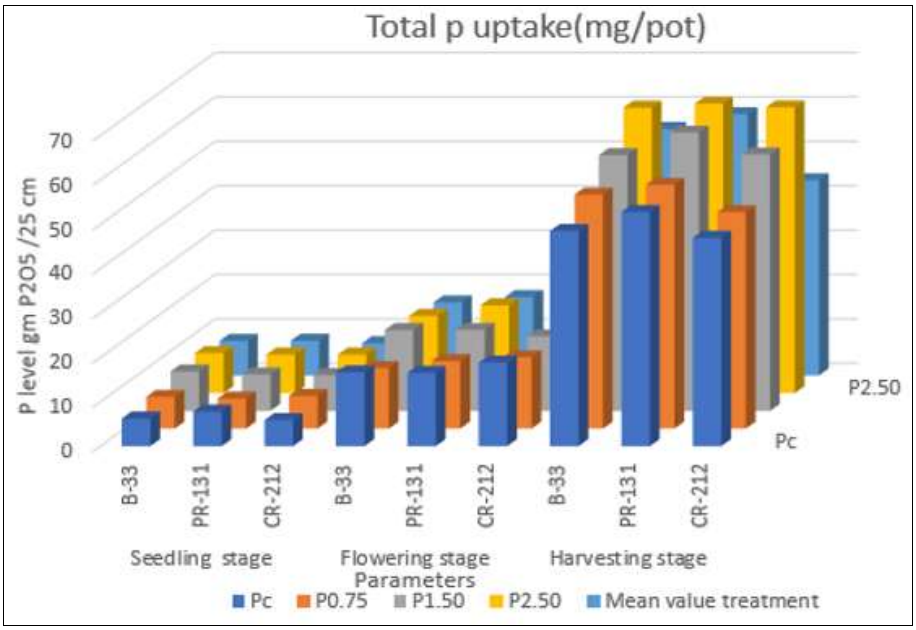

Fig 1: Showing comparison of total p-uptake (mg/pot)

Table- 2 exhibits that % P derived from fertilizers increased significantly with increasing level of P in all growth parameters of all varieties of crop rice with their respective controls. This might be due to the fact that more the phosphate fertilizer added to soil more the crop removal. On the other hand, the P fixation capacity of soil being limited the pool of availability absorbed by the plants which is also explained by bar diagram given below in fig. B.

Table 2: Effect of P level on P derived from fertilizer (%) by crop rice at different stages of growth parameters

P levels gmP_2O_5/ 25 cm	Seedling Stage			Flowering Stage			Harvesting Stage		
	B-33	PR-131	CR-212	B-33	PR-131	CR-212	B-33	PR-131	CR-212
P_C	-	-	-	-	-	-	-	-	-
$P_{0.75}$	22.80	21.00	20.39	40.17	40.37	39.73	62.85	61.58	71.45
$P_{1.50}$	26.16	32.39	27.35	46.76	47.57	47.11	62.50	60.42	72.77
$P_{2.50}$	30.59	35.78	43.51	52.34	51.41	50.01	63.17	66.70	63.41
Mean ±SE	19.89±(0.01)	22.54±(0.03)	25.32±(0.03)	34.82±(0.20)	44.84±(0.15)	34.22±(0.01)	47.23±(0.30)	47.21±(0.03)	51.91±(0.02)
Effect	P		V	P		V	P		V
±Sem	0.034		0.052	0.063		0.066	0.082		0.081
F	583.2**		753.46**	1281.23***		914.30***	894.01***		351.20**
CD	0.02		0.03	0.35		0.02	1.53		2.01

**p<0.01, ***p<0.001 at 5% level

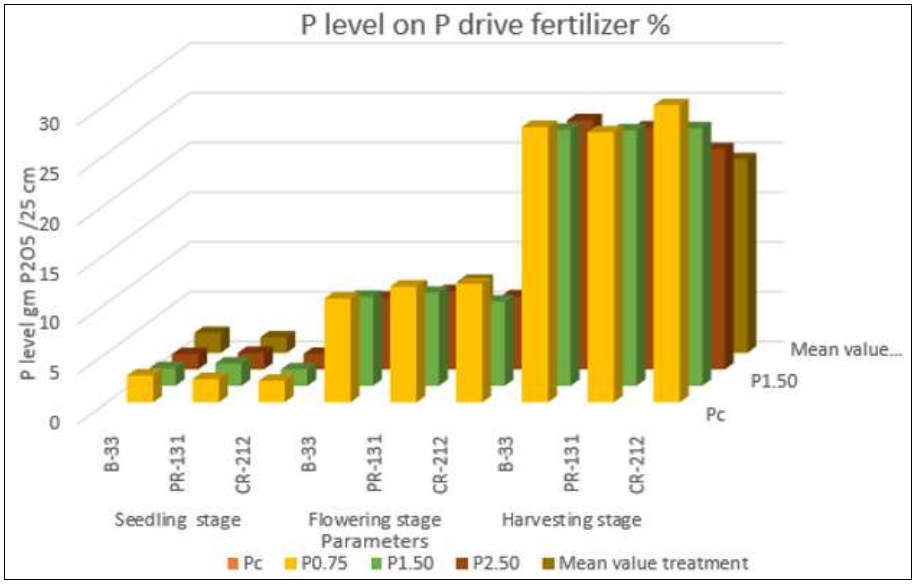

Fig 2: Showing comparison of phosphorus level on phosphorus obtained from fertilizer (%)

Data presented in table-3 reveals that the % utilization of P decreased significantly with increasing levels of P at all the stages of growth parameters in all varieties, changes in growth parameters due to treatment doses are shown by bar diagram in fig. C, which means that the utilization of added P was not in proportion to applied P level. On the other hand, with lower dose the available amount of P was less than the need of the crop for its growths as a result of which the efficiency of utilization of applied fertilizer P is higher at low dose and low at higher dose [7, 8, 9].

Table 3: Effect of P level on P utilization (%) by crop rice at different stages of growth parameters

P levels gmP_2O_5/ 25 cm	Seedling Stage			Flowering Stage			Harvesting Stage		
	B-33	PR-131	CR-212	B-33	PR-131	CR-212	B-33	PR-131	CR-212
P_C	-	-	-	-	-	-	-	-	-
$P_{0.75}$	2.69	2.34	2.16	10.41	11.63	11.90	27.66	27.13	29.85
$P_{1.50}$	1.79	2.25	1.66	8.95	9.35	8.46	25.72	25.66	25.88
$P_{2.50}$	1.53	1.65	1.56	7.19	7.86	7.34	25.02	24.29	22.12
Mean ±SE	2.00 ±(0.01)	1.56 ±(0.10)	1.35 ±(0.02)	6.64 ±(0.13)	7.21 ±(0.02)	6.93 ±(0.14)	19.63 ±(0.03)	19.27 ±(0.13)	19.45 ±(0.16)
Effect	P		V	P		V	P		V
±Sem	0.032		0.063	0.020		0.032	0.003		0.005
F	148.02**		168.03**	190.003***		156.06***	110.09***		130.13**
CD	0.20		0.33	0.13		0.20	1.05		0.39

**p<0.01, ***p<0.001 at 5% level

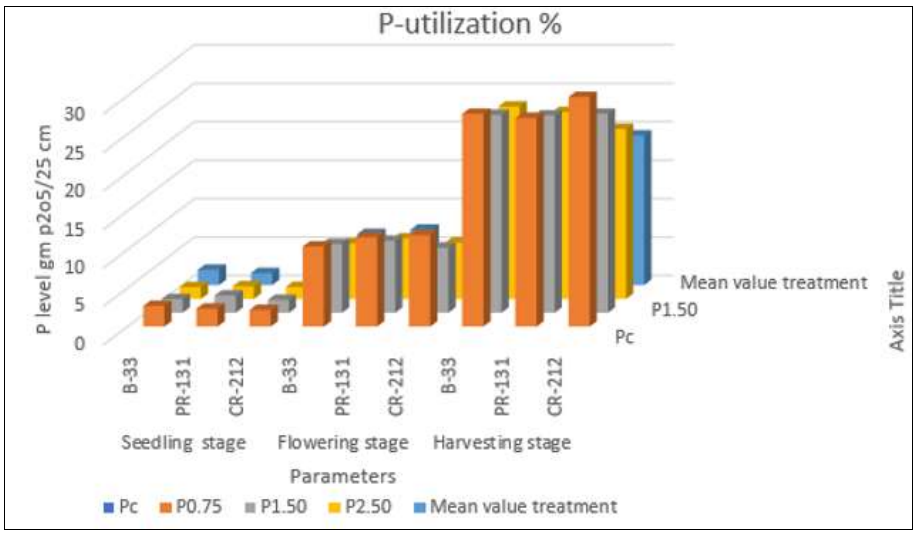

Fig 3: Showing comparative effect of P-utilization (%)

It is evident from table-4 and fig. D that as the dose of P increased, the uptake of P from soil sources also increased at all the growth stages. This might be due to the proportionately higher uptake of P with increased dry matter yield of crops as well as better root system development caused by P application which enabled the plant to exploit the P from soil to a greater extent [9].

Table 4: Effect of P level on soil P-uptake (mg /pot) by crop rice at different stages of growth parameters

P levels	Seedling Stage			Flowering Stage			Harvesting Stage		
gmP_2O_5/ 25 cm	B-33	PR-131	CR-212	B-33	PR-131	CR-212	B-33	PR-131	CR-212
P_C	6.23	7.79	5.90	16.62	16.54	18.84	48.51	52.75	4.95
$P_{0.75}$	7.12	6.73	7.37	13.67	15.19	16.05	52.70	54.92	48.75
$P_{1.50}$	8.88	8.22	8.09	18.21	18.23	16.78	57.63	62.69	57.77
$P_{2.50}$	9.04	8.70	8.69	17.43	19.78	19.87	64.32	65.22	64.39
Mean ±SE	7.80 ±(0.01)	7.86 ±(0.10)	7.29 ±(0.12)	16.48 ±(0.16)	17.68 ±(0.02)	17.88 ±(0.11)	55.54 ±(0.13)	58.89 ±(0.20)	44.00 ±(0.10)
Effect	P		V	P		V	P		V
±Sem	0.032		0.026	0.020		0.037	0.082		0.018
F	1100.01**		128.012**	326.023***		124.02***	289.39***		360.32**
CD	0.08		0.16	0.19		0.23	0.17		0.15

**p<0.01, ***p<0.001 at 5% level

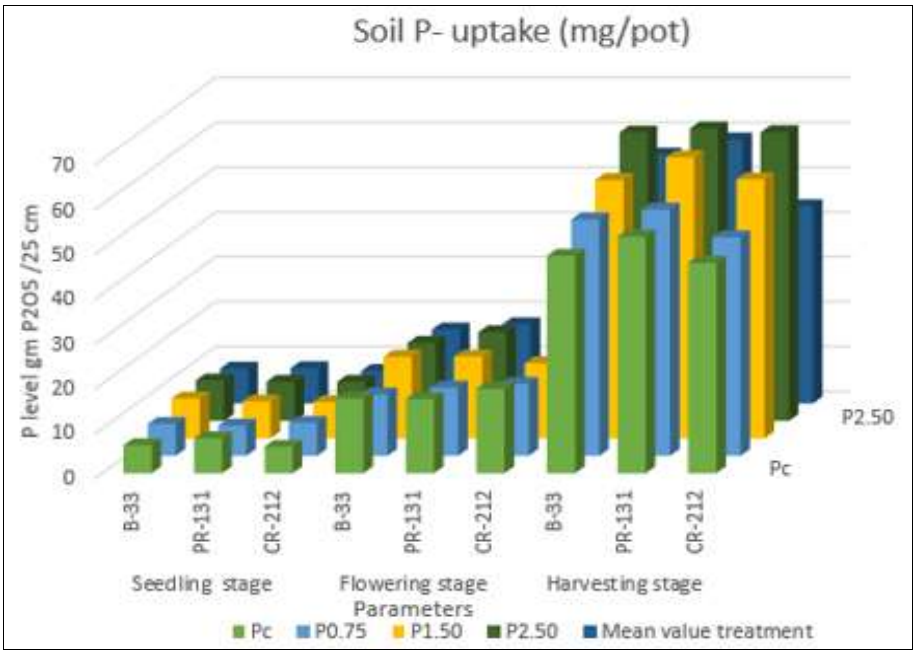

Fig 4: Showing comparative effect of P-uptake on soil (mg/pot)

The data given in table-5 and its bar diagram (Fig. E) reveal that dry matter yield of crop rice increased at all the stages of growth parameter of all varieties of crop rice with increasing level of P with their respective controls. This increasing yield was due to the response of P over control indicating that the soil was not in a position to supply enough P as required by the crop rice and as soon as the P deficiency was made up, increased yield was obtained [9, 10].

Table 5: Effect of P level on dry matter production of crop rice at different stages of growth parameters (gm/pot)

P levels	Seedling Stage			Flowering Stage			Harvesting Stage		
gmP_2O_5/ 25 cm	B-33	PR-131	CR-212	B-33	PR-131	CR-212	B-33	PR-131	CR-212
P_C	3.57	4.37	3.81	8.10	7.57	8.41	14.87	19.53	18.53
$P_{0.75}$	3.25	4.57	4.14	9.80	10.31	11.22	23.59	22.28	22.26
$P_{1.50}$	5.71	5.39	4.60	11.70	12.10	11.84	25.15	26.51	25.33
$P_{2.50}$	5.77	5.51	5.15	11.59	12.69	12.37	27.88	27.78	22.04
Mean ±SE	4.58 ± (0.10)	4.96 ±(0.12)	4.43 ±(0.12)	10.10 ±(0.10)	10.68 ±(0.20)	10.96 ±(0.10)	22.87 ±(0.30)	24.02 ±(0.01)	22.04 ±(0.02)
Effect	P		V	P		V	P		V
±Sem	0.015		0.0013	0.028		0.0024	0.002		0.081
F	150.02**		256.002**	118.03**		389.02	188.02**		360.03***
CD	0.34			0.63		0.02	0.01		0.56

**p<0.01, ***p<0.001 at 5% level

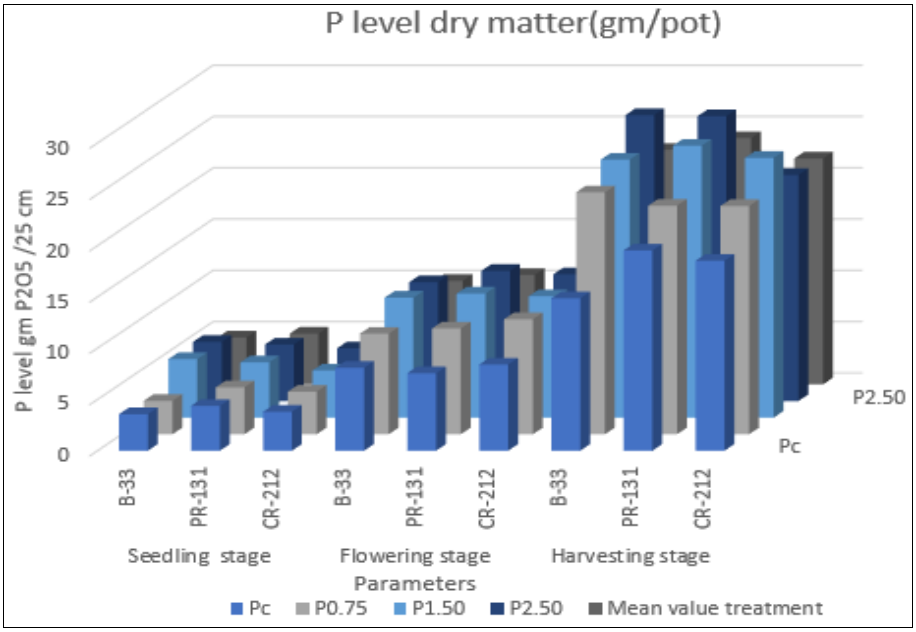

Fig 5: Showing comparative effect of P-level on dry matter (mg/pot)

Finally we have come to the conclusion that 0.40 mCi/gm this amount of radioactive phosphorus obtained from the analysis of plant waste materials does not have any deleterious effect on plants and ecological environment as well, while positive results are being obtained from the above fact that application of increasing doses of phosphorus fertilizer brings about increased uptake of P in all the varieties of the crop rice, increased dry matter yield and increased uptake of P from soil sources. The phosphorus derived from fertilizer also increase but % age utilization of applied P decrease indicating thereby that the efficiency of P utilization is lower level of fertilization then at higher doses.

Conclusion

On the basis of above results of grain yield and uptake of rice we can say that there is a possibility of saving of phosphorus fertilizer from above recommended doses also be followed successfully in rice crop without any adverse effect on grain yield of rice crop growing in ^{32}P accumulated soil. Finally we have come to the conclusion that this amount of radiation phosphorus obtained from the analysis of plant waste material which was 0.40 mCi/gm. It does not have any deleterious effect on the plants and the ecology of the environment as well.

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