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Effect of different sources of organic manures on phosphorus availability in vertisol

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Abstract
An incubation study was conducted during 2024-2025 with six treatments *viz.*, Absolute control, GRDF (50:75:45 N: P_2O_5:K_2O Kg ha^{-1} + FYM 10 t ha^{-1}), RD NK+100% RD- P_2O_5 + PMC 2.0 t ha^{-1}, RD NK+75% RD- P_2O_5 + PMC 4.0 t ha^{-1}, RD NK +100% RD- P_2O_5 + PROM 0.5 t ha^{-1} and RD NK + 75% RD- P_2O_5 + PROM 1.0 t ha^{-1} and four replications to study the periodical release of phosphorus at 15 days interval up to 90 days. The result revealed that the application of RD NK+75% RD- P_2O_5 + PROM 1.0 t ha^{-1} recorded significantly higher available phosphorus (17.77, 20.03, 25.26, 28.91, 30.12 and 30.51 mg kg^{-1}) over rest of treatments during incubation at 15, 30, 45, 60, 75 and 90 days of incubation, respectively.
The organic carbon and soil available potassium was significantly higher (0.54% and 416.20 kg ha^{-1}, respectively) with application of GRDF -50:75:45 N: P_2O_5:K_2O kg ha^{-1} + FYM 10 t ha^{-1} at 90 days of incubation period. The soil available phosphorus shows highly significant and positive correlation with OC, available N and K, however it shows a significant negative correlation with $CaCO_3$.

Keywords: Phosphorus, Organic manures, Soil properties

Introduction
Phosphorus (P) is the second most important macronutrient, essential for plant growth, next to nitrogen. It plays a crucial role in driving biochemical processes in plants as a component of adenosine triphosphate (ATP), which is the energy currency for these processes. Phosphorus is added in soil through application of chemical fertilizers but a major part of it gets fixed in the soil, while 15-20% is utilized by the crop (Wani, 1980) [5]. The main issues related to phosphorus in soil are its low mobility, the limited availability of phosphorus to plants, and fixation. Motsara (2001) [3] noted that 49.3% of Indian soils exhibit low phosphorus levels. Vertisols have a high clay content (more than 30%), high water-holding capacity, alkaline in pH and dominated by calcium.
The recovery of both applied and native phosphorus is quite low, and the rising cost of chemical phosphatic fertilizers is becoming a significant concern for farmers. There is need to identify effective solutions that can enhance the efficiency of P fertilizer use while also improving the recovery and solubility of applied P fertilizers in the soil. Soil organic amendments can increase the availability of phosphorus in several ways. Soils that are rich in organic matter are expected to have a higher availability of phosphorus due to increased biological activity. Organic manures release substances that improve the solubilization and retention of phosphorus in soil. Organic manures, such as FYM, PMC and PROM, demonstrate a slow and sustained release of phosphorus during incubation.

Materials and Methods
An incubation study was conducted at the Division of Soil Science, RCSM College of Agriculture, Kolhapur during 2024-2025. The bulk soil sample from 0-15 cm belonging to the Vertisol was collected from the research farm, RCSM College of Agriculture, Kolhapur. The soil sample was collected, air-dried, grounded with a wooden mortar and pestle, and then sieved through 2.0 mm sieve. The experiment was laid out in CRD design with six treatments *viz.*, Absolute control, GRDF (50:75:45 N: P_2O_5:K_2O Kg ha^{-1} + FYM 10 t ha^{-1}), RD NK+100% RD- P_2O_5 + PMC 2.0 t ha^{-1}, RD NK+75% RD- P_2O_5 + PMC 4.0 t ha^{-1}, RD

NK +100% RD- P_2O_5 + PROM 0.5 t ha $^{-1}$ and RD NK + 75% RD- P_2O_5 + PROM 1.0 t ha $^{-1}$ and four replications. The experimental soil was alkaline in reaction, medium in available nitrogen, moderately high in phosphorus and very high in potassium. The incubation study was conducted by discard method for 90 days. The soil samples were analysed for available phosphorus at 0,15, 30, 45, 60, 75 and 90 days after incubation (DAI). After completion of incubation the soil samples were analysed for soil chemical properties *viz.* pH, EC, OC, $CaCO_3$, available N, P and K.

Result and discussion

P availability during incubation

The result revealed that the available phosphorus increased with incubation period, and it was maximum at 90 days of incubation (Table.1 and Fig.1). Application of RD NK+75% RD- P_2O_5 + PROM 1.0 t ha^{-1} recorded significantly highest available phosphorus (17.77, 20.03, 25.26, 28.91, 30.12 and 30.51 mg kg^{-1}) over rest of treatments during incubation at 15, 30, 45, 60, 75 and 90 days of incubation, respectively. The available phosphorus release rate was maximum at 30 to 45 days of incubation and the treatment RD NK+75% RD- P_2O_5 + PROM 1.0 t ha^{-1} recorded the higher release rate as compared to rest of the treatments. Similar results were obtained by Bagade *et al.*, (2025) [1], Walpola *et al.*, (2020) [4].

Soil chemical properties

The soil pH, EC and $CaCO_3$ were did not differ significantly with application of different sources of organic manures. The treatment GRDF recorded significantly higher organic carbon and soil available potassium (0.54% and 416.20 kg ha^{-1}, respectively) at 90 days of incubation, however the soil available nitrogen (257.50 kg ha^{-1}) at 90 days of incubation was significantly higher with application of RD NK+75% RD- P_2O_5 + PMC 4.0 t ha^{-1} over control treatment (Table 2). These results are in conformity with Kumari *et al.*, (2024) [2].

Correlation between available phosphorus and soil properties

The soil available phosphorus at 90 days of incubation showed highly significant and positive correlation with soil organic carbon, available N, and K; however, it shows significant and negative correlation with calcium carbonate content in soil (Table 3).

Table 1: Effect of different sources of organic manures on Phosphorus availability

Tr. No.	Treatments	Available Phosphorus (mg kg^{-1})							Cumulative available P (mg kg^{-1})
		0 DAI	15 DAI	30 DAI	45 DAI	60 DAI	75 DAI	90 DAI	
T_1	Absolute control	11.92	11.97	12.09	12.27	12.47	12.64	12.75	86.11
T_2	GRDF	12.27	16.93	18.03	21.63	24.74	26.77	28.55	148.92
T_3	RD-NK+ 100% RD- P_2O_5 + PMC 2.0 t ha $^{-1}$	12.10	17.20	18.18	20.91	22.25	23.14	23.70	137.48
T_4	RD-NK+ 75% RD- P_2O_5 + PMC 4.0 t ha $^{-1}$	12.14	16.06	18.77	22.64	25.61	27.66	29.09	151.97
T_5	RD-NK+ 100% RD- P_2O_5 + PROM 0.5 t ha $^{-1}$	12.36	17.70	19.12	23.50	26.93	27.99	28.45	156.04
T_6	RD-NK+ 75% RD- P_2O_5 + PROM 1.0 t ha $^{-1}$	12.41	17.77	20.03	25.26	28.91	30.12	30.51	165.01
	SEm+	0.24	0.64	0.74	1.25	1.41	1.14	0.67	
	CD @ 0.05	NS	1.89	2.19	3.72	4.18	3.39	1.98	

Table 2: Effect of different sources of organic manures on soil chemical properties and soil available nutrients

Tr. No.	Treatments	Soil Chemical Properties				Available Nutrients (kg ha^{-1})		
		pH (1:2.5)	EC (dS m^{-1})	OC (%)	$CaCO_3$ (%)	N	P	K
T_1	Absolute control	7.9	0.36	0.48	9.74	185.96	28.59	352.65
T_2	GRDF	7.88	0.4	0.54	9.72	252.18	64.01	416.20
T_3	RD-NK+ 100% RD- P_2O_5 + PMC 2.0 t ha $^{-1}$	7.8	0.38	0.50	9.71	255.93	53.14	392.64
T_4	RD-NK+ 75% RD- P_2O_5 + PMC 4.0 t ha $^{-1}$	7.78	0.39	0.51	9.7	257.50	65.22	398.18
T_5	RD-NK+ 100% RD- P_2O_5 + PROM 0.5 t ha $^{-1}$	7.91	0.37	0.49	9.72	251.19	63.78	383.55
T_6	RD-NK+ 75% RD- P_2O_5 + PROM 1.0 t ha $^{-1}$	7.92	0.38	0.50	9.71	252.41	68.40	385.77
	SEm+	0.04	0.01	0.01	0.24	5.64	1.49	7.94
	CD @ 0.05	NS	NS	0.03	NS	16.76	4.43	23.58

Table 3: Correlation between soil available phosphorus and soil properties

	Available phosphorus at 90 days
pH	-0.075
EC	0.582**
OC	0.524**
$CaCO_3$	-0.448*
Available N	0.934**
Available K	0.758**

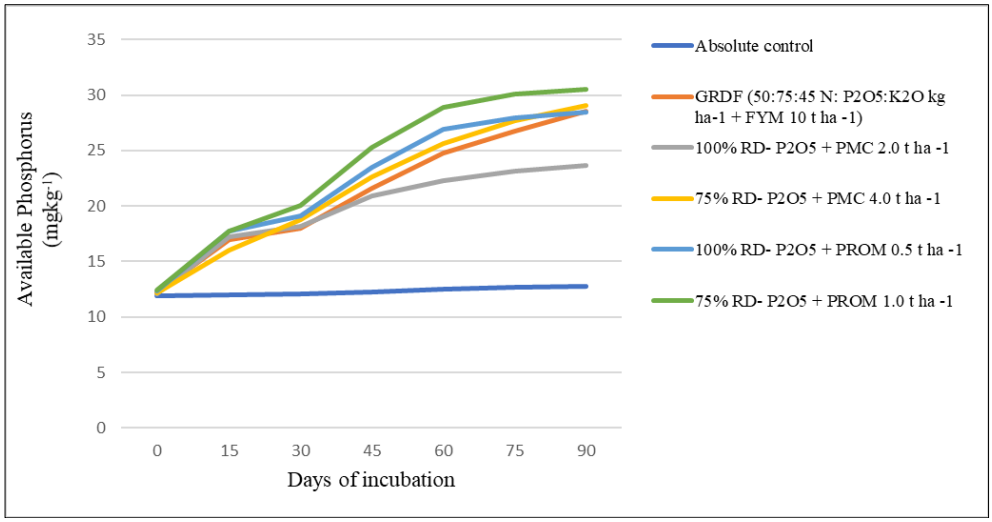

Fig 1: Effect of different organic manures on available Phosphorus during incubation

Conclusion

An application of RD NK+75% RD - P_2O_5 + PROM 1.0 t ha^{-1} found superior for phosphorus availability and overall improvement in the soil fertility status of Vertisol and it was followed by RD NK+75% RD - P_2O_5 + PMC 4.0 t ha^{-1} and GRDF (50:75:45 N: P_2O_5:K_2O kg ha^{-1} + FYM 10 t ha^{-1}).

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