The Andhra Agric. J 67 Spl: (IARD-2020): 28-36

Effect of Organic Manures and Levels of Phosphorus on Physico-Chemical Properties of Soils Under Rice-Blackgram Cropping Sequence

I Jagga Rao, Ch Sujani Rao, P R K Prasad, Ch Pulla Rao and K Jayalalitha
Department of Soil Science and Agricultural Chemistry, Agricultural College, Bapatla, A. P.

ABSTRACT

A field experiment entitled "Phosphorus dynamics in relation to nutrient management in rice-blackgram cropping sequence" was conducted for two consecutive years (2017-2018 and 2018-2019) at Agricultural College Farm, Bapatla. The experimental soil was clay loam in texture, slightly alkaline in reaction, low in organic carbon and available nitrogen, medium in available phosphorus and high in available potassium. However, DTPA extractable micro-nutrients (Fe, Mn, Zn and Cu) were found to be above the critical limits. Further, the results revealed that significantly the lowest pH and EC were observed due to application of 100% RDNK with the combination of *Dhaincha* 10 t ha^{-1} over RDNK alone at different growth stages of rice crop. However, the pH and EC were not significantly differed among the P levels from 0 to 120 kg P_2O_5/ha^{-1}. Similar trend was followed at both flowering and harvest in succeeding blackgram.

Key words: *Organic manures, Phosphorus levels, pH and EC.*

Low soil fertility due to monoculture cereal production systems, inadequate fertilizer application, biomass removal, soil erosion, nutrient losses through runoff and leaching are recognised as some of the major causes for declining crop production in developing countries (Negassa *et al*. 2007). Application of inorganic fertilizers is considered the most efficient way to reverse soil nutrient depletion and improve crop production (Bationo *et al.*, 2007). However, the use of inorganic fertilizers in developing countries is insignificant as most of the smallholder farmers cannot afford even a single bag to apply to their crops (Tesfa *et al*., 2001). Continuous use of chemical fertilizers in intensive cropping systems leads to increased soil acidity and nutrient imbalance which adversely affects soil health due to their susceptibility to losses through gaseous form and by leaching (Amoah *et al.*, 2012). These effects can be alleviated through the use of organic fertilisers which can improve soil physical and chemical properties. Among several agronomic management practices that affect the productivity of rice, fertilizer application is very important, especially phosphorus which plays an important role in growth and development of rice crop. Keeping this in view an effort has been made to know the more productive and profitable fertilizer levels of phosphorus to maintain ecological sustainability and economic soundness through adoption of best nutrient management practices.

MATERIAL AND METHODS

A field experiment was conducted on "phosphorus dynamics in relation to nutrient management in rice- blackgram cropping sequence" at Agricultural College Farm, Bapatla for two consecutive years (2017-2018 and 2018-2019). The experimental soil was clay loam in texture, slightly alkaline in reaction, low in organic carbon and low in available nitrogen, medium in available phosphorus and high in available potassium and micro-nutrients such as Fe, Mn, Zn and Cu were above their critical levels. The experiment was laid out in a split plot design and replicated thrice. The treatments consisted of RDNK (M_0), RDNK+FYM @ 5t ha^{-1} (M_1), RDNK+sunhemp @ 10t ha^{-1} (M_2) and RDNK+*Dhaincha* @ 10t ha^{-1}(M_3) as main plots and five phosphorus levels to rice crop comprising of 0 kg P_2O_5 ha^{-1} (P_1), 30 kg P_2O_5 ha^{-1} (P_2) and 60 kg P_2O_5 ha^{-1} (P_3), 90 kg P_2O_5 ha^{-1} (P_4) and 120 kg P_2O_5 ha^{-1} (P_5) as sub- plot treatments. These treatments were imposed to rice crop during *kharif* season. The soil physico- chemical properties *viz.,* Soil reaction (pH) was measured by using glass electrode pH meter in 1:2.5 ratio of soil water suspension (Jackson, 1973) and electrical onductivity is measured with supernatent liquid of 1:2 soil water suspensions by using electrical conductivity meter (Jackson, 1973).

RESULTS AND DISCUSSION

Soil reaction (pH)

Data pertaining to pH of soil as influenced by various organic manure treatments and phosphorus levels were presented in tables 1, 2 and 3. During both the years, the pH of soil differed significantly due to organic manure treatments only. While phosphorus levels as well as interaction of organic manures and

phosphorus levels did not cause any significant differences.

During both the years (2017 & 18) of investigation the lowest pH was observed in the treatment (M_3) where 100% RDNK was applied in combination with *Dhaincha* 10 t ha^{-1} (7.52, 7.50, 7.47 in 2017 and 7.51, 7.48, 7.46 in 2018 at tillering, panicle initiation and at harvest, respectively). However, this treatment was on par with RDNK+ sunhemp 10 t ha^{-1} (M_2- 7.54, 7.53, 7.49 in 2017 and 7.54, 7.51, 7.47 in 2018), RDNK+ FYM 5 t ha^{-1} (M_1-7.64, 7.63, 7.60 in 2017 and 7.55 7.54, 7.50 in 2018) at all growth stages of rice. Highest soil pH was recorded in the treatment receiving RDNK alone (M_0-7.72, 7.70, 7.68 in 2017 and 7.67, 7.65 and 7.60 in 2018).

The pH decreased with the application of increased doses of P during both the years of study. The mean values pertaining to soil pH recorded under five P levels i.e. P_1 (7.64, 7.62, 7.60 in 2017 and 7.60, 7.57, 7.54 in 2018), P_2 (7.63, 7.61, 7.58 in 2017 and 7.58, 7.56, 7.52 in 2018), P_3 (7.61, 7.59, 7.56 in 2017 and 7.57, 7.55, 7.51 in 2018), P_4 (7.59, 7.57, 7.55 in 2017 and 7.56, 7.53, 7.49 in 2018) and P_5 (7.58, 7.56, 7.53 in 2017) and 7.53, 7.52, 7.48 in 2018) at tillering, panicle initiation and at harvest, respectively. However the difference was statistically not significant.

The addition of organics in the form of FYM @ 5 t ha^{-1} and green manuring @ 10 t ha^{-1} reduces the soil pH over initial value (7.81). This could be due to the release of organic acids during the process of decomposition of the organic compounds. Application of FYM and green manuring in combination with chemical fertilizer reduced the soil pH as compared to RDNK after harvesting of rice crop. Smiciklas *et al.* (2002) also observed a decrease in soil pH after the use of organic materials. The production of organic acids during mineralization of organic materials by heterotrophs and nitrification by autotrophs would have caused this decrease in soil pH (Sarwar *et al.*, 2009).

After 6 cycles of rice-wheat, Kumar and Singh (2010) observed the decrease in soil pH from initial value of 8.5 particularly when green manuring and organic manures were added. The decrease in the soil pH due to the formation of organic and inorganic acids as a result of organic matter decomposition and more CO_2 was formed with increasing metabolic activity of the root system.

Electrical conductivity (EC)

Data pertaining to electrical conductivity presented in tables 4, 5 and 6. The results indicated that during both the years, the EC of soil differed significantly due to organic manure treatments only while phosphorus levels as well as interaction of organic manures and phosphorus levels did not cause any significant differences.

During both the years of investigation lowest EC values (0.41, 0.45, 0.46, 0.46, 0.49 and 0.51 dS m^{-1}) were observed in the treatment that received (M_3) 100% RDNK in combination with *Dhaincha* 10 t ha^{-1} at tillering, panicle initiation and harvest in 2017 and 2018, respectively. However, this treatment remained on par with M_2 (RDNK+ sunhemp 10 t ha^{-1}), M_1 (RDNK+ FYM 5 t ha^{-1}) at all stages of rice and recorded significantly lowest EC over M_0 (0.49, 0.52, 0.53, 0.54, 0.0.59, and 0.61 dS m^{-1}). The EC increased with the application of increased doses of P levels during both the years of study but these differences were not statistically significant.

The data pertaining to electrical conductivity indicated that EC of all the treatments were higher over initial. The findings were in consonance with the results reported by Sharma *et al.* (2007). A trend of general increase in EC of normal soil was observed after rice and wheat crops by application of FYM and green manuring alone or in combination with chemical fertilizer. Although EC of the soil increased in different treatments but the actual values did not cross the critical limit of 4.0 dS m^{-1}. Such similar results were reported by Sarwar *et al* (2008) which indicated increased EC in acidic as well as in alkaline soils when organic materials of different nature were applied to the soil.

Even use of organics showed higher values for electrical conductivity than initial but not much higher, which might probably be due to solubilising effect of organic acids on various compounds in soil. The decomposition of organic materials released acids or acid forming compounds that reacted with the sparingly soluble salts already present in the soil and either converted them into soluble salts or at least increased their solubility (Sarwar *et al.*, 2009). Similar results could also be quoted by Sarwar *et al* (2008) which indicated the increased EC in soil when organic materials of different nature were applied. But the increase in soil EC was not much which might be due to good infiltration rate of soil mitigating the increase in soil EC (Tandon., 2000).

Soil reaction (pH)

Data pertaining to pH of soil as influenced by various organic manure treatments and phosphorus levels to preceeding rice crop was presented in tables 7 and 8. During both the years, the pH of soil differed significantly due to organic manure treatments only. While phosphorus levels as well as interaction of organic manures and phosphorus levels did not cause any significant differences.

Significantly lowest pH was recorded in the treatment (M_3) where 100% RDNK was applied in

Table 1. Effect of organic manures and inorganic P fertilizer on soil pH at tillering stage of rice

P levels (kg P_2O_5 ha^{-1})	*Kharif* 2017				Mean	*Kharif* 2018				Mean
	Organic manures					Organic manures				
	M_0	M_1	M_2	M_3		M_0	M_1	M_2	M_3	
P_1– 0	7.75	7.68	7.58	7.57	7.64	7.69	7.58	7.57	7.54	7.6
P_2– 30	7.74	7.67	7.56	7.53	7.63	7.68	7.57	7.56	7.53	7.58
P_3– 60	7.73	7.64	7.55	7.52	7.61	7.67	7.55	7.54	7.51	7.57
P_4– 90	7.71	7.62	7.52	7.5	7.59	7.66	7.54	7.52	7.49	7.56
P_5– 120	7.69	7.61	7.51	7.49	7.58	7.64	7.52	7.5	7.47	7.53
Mean	7.72	7.64	7.54	7.52		7.67	7.55	7.54	7.51	
	SEm ±		CD (p=0.05)		CV (%)	SEm ±		CD (p=0.05)		CV (%)
M	0.04		0.15		7.2	0.04		0.13		7.8
P	0.11		NS		6.9	0.04		NS		6.3
M at P	0.22		NS			0.07		NS		
P at M	0.2		NS			0.08		NS		

Table 2. Effect of organic manures and inorganic P fertilizer on soil pH at panicle initiation stage of rice

P levels (kg P_2O_5 ha^{-1})	*Kharif* 2017				Mean	*Kharif* 2018				Mean
	Organic manures					Organic manures				
	M_0	M_1	M_2	M_3		M_0	M_1	M_2	M_3	
P_1– 0	7.74	7.66	7.56	7.53	7.62	7.68	7.56	7.54	7.51	7.57
P_2– 30	7.72	7.65	7.55	7.52	7.61	7.66	7.55	7.53	7.5	7.56
P_3– 60	7.71	7.63	7.52	7.5	7.59	7.65	7.54	7.51	7.49	7.55
P_4– 90	7.69	7.61	7.51	7.49	7.57	7.63	7.52	7.5	7.47	7.53
P_5– 120	7.67	7.59	7.5	7.47	7.56	7.61	7.51	7.49	7.45	7.52
Mean	7.7	7.63	7.53	7.5		7.65	7.54	7.51	7.48	
	SEm ±		CD (p=0.05)		CV (%)	SEm ±		CD (p=0.05)		CV (%)
M	0.05		0.16		7.8	0.04		0.13		6.9
P	0.06		NS		7.5	0.04		NS		6.9
M at P	0.12		NS			0.08		NS		
P at M	0.12		NS			0.08		NS		

M_0- No Organic manure
M_1- RDNK+FYM 5 t ha^{-1}
M_2- RDNK+Sunhemp 10 t ha^{-1}
M_3- RDNK+Dhaincha 10 t ha^{-1}

Table 3. Effect of organic manures and inorganic P fertilizer on soil pH at harvest of rice

P levels ($kg\ P_2O_5\ ha^{-1}$)	*Kharif* 2017				Mean	*Kharif* 2018				Mean
	Organic manures					Organic manures				
	M_0	M_1	M_2	M_3		M_0	M_1	M_2	M_3	
P_1– 0	7.71	7.64	7.53	7.51	7.6	7.63	7.54	7.5	7.49	7.54
P_2– 30	7.7	7.62	7.51	7.49	7.58	7.62	7.51	7.48	7.48	7.52
P_3– 60	7.68	7.61	7.49	7.47	7.56	7.6	7.49	7.47	7.46	7.51
P_4– 90	7.67	7.59	7.48	7.45	7.55	7.58	7.48	7.45	7.44	7.49
P_5– 120	7.65	7.56	7.46	7.44	7.53	7.57	7.46	7.44	7.43	7.48
Mean	7.68	7.6	7.49	7.47		7.6	7.5	7.47	7.46	
	SEm ±		CD (p=0.05)		CV (%)	SEm ±		CD (p=0.05)		CV (%)
M	0.04		0.14		8.1	0.04		0.12		7.8
P	0.04		NS		7.6	0.05		NS		8.2
M at P	0.07		NS			0.1		NS		
P at M	0.07		NS			0.09		NS		

Table 4. Effect of organic manures and inorganic P fertilizer on EC (d Sm^{-1}) of soil at tillering stage of rice

P levels ($kg\ P_2O_5\ ha^{-1}$)	*Kharif* 2017				Mean	*Kharif* 2018				Mean
	Organic manures					Organic manures				
	M_0	M_1	M_2	M_3		M_0	M_1	M_2	M_3	
P_1– 0	0.46	0.42	0.41	0.39	0.42	0.51	0.49	0.44	0.43	0.47
P_2– 30	0.47	0.44	0.42	0.4	0.44	0.53	0.5	0.46	0.44	0.48
P_3– 60	0.49	0.45	0.44	0.42	0.45	0.54	0.52	0.47	0.45	0.5
P_4– 90	0.5	0.47	0.45	0.43	0.46	0.56	0.53	0.49	0.47	0.51
P_5– 120	0.51	0.48	0.47	0.44	0.48	0.57	0.54	0.51	0.49	0.53
Mean	0.49	0.45	0.44	0.41		0.54	0.52	0.47	0.46	
	SEm ±		CD (p=0.05)		CV (%)	SEm ±		CD (p=0.05)		CV (%)
M	0.02		0.05		7.1	0.03		0.07		6.9
P	0.02		NS		8.8	0.03		NS		6.4
M at P	0.04		NS			0.06		NS		
P at M	0.04		NS			0.06		NS		

M_0- No Organic manure
M_1- RDNK+FYM 5 t ha^{-1}
M_2- RDNK+Sunhemp 10 t ha^{-1}
M_3- RDNK+Dhaincha 10 t ha^{-1}

Table 5. Effect of organic manures and inorganic P fertilizer on EC (d Sm^{-1}) of soil at panicle initiation stage of rice

P levels (kg P_2O_5 ha^{-1})	*Kharif* 2017				Mean	*Kharif* 2018				Mean
	Organic manures					Organic manures				
	M_0	M_1	M_2	M_3		M_0	M_1	M_2	M_3	
P_1– 0	0.49	0.44	0.43	0.42	0.44	0.55	0.53	0.47	0.45	0.50
P_2– 30	0.50	0.46	0.44	0.43	0.46	0.57	0.55	0.49	0.48	0.52
P_3– 60	0.51	0.48	0.46	0.45	0.48	0.58	0.56	0.51	0.49	0.53
P_4– 90	0.54	0.5	0.48	0.46	0.49	0.61	0.58	0.53	0.51	0.56
P_5– 120	0.55	0.52	0.49	0.48	0.51	0.62	0.6	0.56	0.54	0.58
Mean	0.52	0.48	0.46	0.45		0.59	0.56	0.51	0.49	
	SEm ±		CD (p=0.05)		CV (%)	SEm ±		CD (p=0.05)		CV (%)
M	0.02		0.06		6.1	0.03		0.08		8.5
P	0.02		NS		7.3	0.03		NS		9.3
M at P	0.05		NS			0.06		NS		
P at M	0.05		NS			0.06		NS		

Table 6. Effect of organic manures and inorganic P fertilizer on EC (d Sm^{-1}) of soil at harvest of rice

P levels (kg P_2O_5 ha^{-1})	*Kharif* 2017				Mean	*Kharif* 2018				Mean
	Organic manures					Organic manures				
	M_0	M_1	M_2	M_3		M_0	M_1	M_2	M_3	
P_1– 0	0.50	0.46	0.45	0.43	0.46	0.57	0.55	0.49	0.47	0.52
P_2– 30	0.51	0.48	0.46	0.45	0.48	0.59	0.56	0.50	0.49	0.54
P_3– 60	0.52	0.49	0.47	0.46	0.49	0.60	0.57	0.52	0.51	0.55
P_4– 90	0.55	0.50	0.49	0.47	0.50	0.63	0.60	0.56	0.53	0.58
P_5– 120	0.57	0.51	0.50	0.49	0.52	0.66	0.62	0.58	0.56	0.61
Mean	0.53	0.49	0.47	0.46		0.61	0.58	0.53	0.51	
	SEm ±		CD (p=0.05)		CV (%)	SEm ±		CD (p=0.05)		CV (%)
M	0.02		0.06		9.8	0.02		0.09		7.3
P	0.01		NS		7.6	0.03		NS		6.5
M at P	0.03		NS			0.05		NS		
P at M	0.03		NS			0.05		NS		

M_0- No Organic manure
M_1- RDNK+FYM 5 t ha^{-1}
M_2- RDNK+Sunhemp 10 t ha^{-1}
M_3- RDNK+Dhaincha 10 t ha^{-1}

Table 7. Residual effect of organic manures and inorganic P fertilizer on soil pH of succeeding blackgram at flowering stage in rice based cropping sequence.

P levels (kg P_2O_5 ha^{-1})	*Rabi* 2018				Mean	*Rabi* 2019				Mean
	Organic manures					Organic manures				
	M_0	M_1	M_2	M_3		M_0	M_1	M_2	M_3	
P_1– 0	7.61	7.25	7.22	7.19	7.32	7.54	6.94	6.89	6.86	7.06
P_2– 30	7.55	7.21	7.17	7.16	7.27	7.47	6.91	6.86	6.81	7.01
P_3– 60	7.53	7.15	7.12	7.05	7.21	7.46	6.85	6.82	6.72	6.96
P_4– 90	7.46	7.11	7.08	7.01	7.17	7.11	6.81	6.77	6.63	6.83
P_5– 120	7.43	7.09	7.06	6.99	7.15	7.08	6.79	6.75	6.61	6.81
Mean	7.52	7.16	7.13	7.08		7.33	6.86	6.82	6.73	
	SEm ±		CD (p=0.05)		CV (%)	SEm ±		CD (p=0.05)		CV (%)
M	0.09		0.31		6.9	0.15		0.46		8.1
P	0.08		NS		5.6	0.09		NS		6.3
M at P	0.15		NS			0.17		NS		
P at M	0.16		NS			0.21		NS		

Table 8. Residual effect of organic manures and inorganic P fertilizer on soil pH of succeeding blackgram at harvest in rice based cropping sequence

P levels (kg P_2O_5 ha^{-1})	*Rabi* 2018				Mean	*Rabi* 2019				Mean
	Organic manures					Organic manures				
	M_0	M_1	M_2	M_3		M_0	M_1	M_2	M_3	
P_1– 0	7.57	6.99	6.95	6.92	7.11	7.51	6.9	6.84	6.8	7.01
P_2– 30	7.5	6.96	6.92	6.87	7.06	7.44	6.87	6.81	6.75	6.97
P_3– 60	7.49	6.9	6.88	6.78	7.01	7.43	6.81	6.77	6.66	6.92
P_4– 90	7.14	6.86	6.83	6.69	6.88	7.08	6.77	6.72	6.57	6.79
P_5– 120	7.11	6.84	6.81	6.67	6.86	7.05	6.75	6.7	6.55	6.76
Mean	7.36	6.91	6.88	6.79		7.3	6.82	6.77	6.67	
	SEm ±		CD (p=0.05)		CV (%)	SEm ±		CD (p=0.05)		CV (%)
M	0.13		0.46		8.7	0.15		0.5		8.2
P	0.08		NS		6.3	0.09		NS		6.1
M at P	0.17		NS			0.17		NS		
P at M	0.2		NS			0.2		NS		

M_0- No Organic manure
M_1- RDNK+FYM 5 t ha^{-1}
M_2- RDNK+Sunhemp 10 t ha^{-1}
M_3- RDNK+Dhaincha 10 t ha^{-1}

Table 9. Residual effect of organic manures and inorganic P fertilizer on soil EC (dS m^{-1}) of succeeding blackgram at flowering stage in rice based cropping sequence.

P levels (kg P_2O_5 ha^{-1})	*Rabi* 2018				Mean	*Rabi* 2019				Mean
	Organic manures					Organic manures				
	M_0	M_1	M_2	M_3		M_0	M_1	M_2	M_3	
P_1– 0	0.34	0.32	0.31	0.28	0.31	0.44	0.4	0.36	0.33	0.39
P_2– 30	0.38	0.35	0.32	0.29	0.34	0.46	0.44	0.38	0.35	0.4
P_3– 60	0.39	0.36	0.34	0.32	0.35	0.47	0.45	0.41	0.37	0.41
P_4– 90	0.41	0.37	0.36	0.34	0.37	0.49	0.46	0.42	0.41	0.43
P_5– 120	0.44	0.4	0.38	0.36	0.4	0.51	0.48	0.45	0.43	0.45
Mean	0.39	0.36	0.34	0.32		0.47	0.45	0.41	0.38	
	SEm ±		CD (p=0.05)		CV (%)	SEm ±		CD (p=0.05)		CV (%)
M	0.03		0.12		7.8	0.05		0.16		6.9
P	0.03		0.08		7.2	0.03		0.07		6.5
M at P	0.05		NS			0.05		NS		
P at M	0.06		NS			0.06		NS		

Table 10. Residual effect of organic manures and inorganic P fertilizer on soil EC (dS m^{-1}) of succeeding blackgram at harvest in rice based cropping sequence

P levels (kg P_2O_5 ha^{-1})	*Rabi* 2018				Mean	*Rabi* 2019				Mean
	Organic manures					Organic manures				
	M_0	M_1	M_2	M_3		M_0	M_1	M_2	M_3	
P_1– 0	0.37	0.35	0.34	0.32	0.35	0.43	0.41	0.39	0.35	0.4
P_2– 30	0.41	0.38	0.33	0.3	0.35	0.47	0.46	0.41	0.37	0.43
P_3– 60	0.42	0.38	0.36	0.33	0.37	0.48	0.47	0.45	0.4	0.45
P_4– 90	0.44	0.39	0.37	0.35	0.39	0.49	0.48	0.48	0.41	0.47
P_5– 120	0.45	0.42	0.4	0.37	0.41	0.52	0.51	0.5	0.43	0.49
Mean	0.42	0.38	0.36	0.34		0.48	0.47	0.45	0.39	
	SEm ±		CD (p=0.05)		CV (%)	SEm ±		CD (p=0.05)		CV (%)
M	0.02		0.08		8.3	0.03		0.11		7.1
P	0.02		NS		7.5	0.03		NS		6.6
M at P	0.04		NS			0.07		NS		
P at M	0.04		NS			0.07		NS		

M_0- No Organic manure
M_1- RDNK+FYM 5 t ha^{-1}
M_2- RDNK+Sunhemp 10 t ha^{-1}
M_3- RDNK+Dhaincha 10 t ha^{-1}

combination with *Dhaincha* 10 t ha^{-1} (7.08, 6.79 in 2018 and 6.73, 6.67 in 2019) at flowering and harvest, respectively during both the years of investigation. However, this treatment was on par with RDNK+ sunhemp 10 t ha^{-1} (7.13, 6.88 in 2018 and 6.82, 6.77 in 2019) and M_1 (7.16, 6.91 (2018) and 6.86, 6.82 (2019), respectively). Highest pH was recorded in treatment that received RDNK (M_0-7.52, 7.36 in 2018 and 7.33, 7.30 in 2019) alone at all growth stages. However, with advancement of the stage, the pH of soil was slightly decreased. In the present investigation the soil pH under succeeding blackgram was assessed under various treatments applied to preceeding rice crop during both the years. The pH was decreased with the application of increased doses of P levels during both the years of study, however these differences were not significant.

The soil pH was decreased by the addition of organic manures. This could be due to the release of organic acids during the process of decomposition of the organic compounds. Application of FYM and green manure in combination with chemical fertilizer reduced the soil pH as compared to RDNK after harvesting rice. Pattanayak *et al.* (2001), Yaduvanshi (2001) and Smiciklas *et al.* (2002) also observed a decrease in soil pH after the use of organic materials. The production of organic acids during mineralization of organic materials by heterotrophs and nitrification by autotrophs would have caused this decrease in soil pH (Sarwar *et al.*, 2009). Khusbhoo *et al.* (2016) quoted lowest soil pH in sorghum-berseem cropping system presence leguminous crop led to decrease in soil pH.

Electrical conductivity (EC)

Data set out in tables 9 and 10 would bring about that different organic manures and P levels caused significant variations in EC during both the years of experimentation. Significantly lowest EC (0.32, 0.34 in 2018 and 0.38, 0.39 dS m^{-1} in 2019 at flowering and harvest, respectively was recorded in the treatment (M_3) where 100% RDNK was applied in combination with *Dhaincha* 10 t ha^{-1}. However, this treatment remained on par with M_2 (RDNK+ sunhemp 10 t ha^{-1}) and M_1 (RDNK+ FYM 5 t ha^{-1}), while M_2 was on par with M_1 and M_0. However, the treatment M_0 (0.39, 0.42 (2018) and 0.47, 0.48 dS m^{-1} (2019)) significantly recorded higher EC over M_3.

The EC was increased slightly with the application of increased doses of P during both the years of study but these differences were not statistically significant. The average values recorded in P_1 (0.31, 0.39, 0.35 and 0.40 dS m^{-1}), P_2 (0.34, 0.40, 0.35 and 0.43 dS m^{-1}), P_3 (0.35, 0.41, 0.37 and 0.45 dS m^{-1}), P_4 (0.37, 0.43, 0.39 and 0.47 dS m^{-1}) and P_5 (0.40, 0.45, 0.41 and 0.49 dS m^{-1}) treatments during 2018 and 2019 at flowering and harvest, respectively. However, the interaction effect was not significant. The soil electrical conductivity after harvest of *rabi* blackgram was decreased in the treatment M_3 (RDNK+ *Dhaincha* @10t ha^{-1}) than that of inorganic alone given to preceding rice crop during both the years of study. Mairan *et al.* (2005) concluded that there was decline in values of soil electrical conductivity of Vertisol with crop residue incorporation over fertilizer application in long-term fertilizer experiment with sorghum-sunflower sequence. Khusbhoo *et al.*, 2016 also recorded similar results i.e the lowest EC values were reported in maize-wheat- greengram cropping system. It might be attributed that more organic matter provided by these crops which decreased the bulk density, an enhancement of soil porosity, aeration and permeability of soil thereby reducing soil salinity and reduced the EC values (Rathod *et al.*, 2003).

CONCLUSION

Significantly lowest pH and EC was observed in the treatment (M_3) where 100% RDNK was applied in combination with *Dhaincha* 10 t ha^{-1} over RDNK alone (M_0) at tillering, panicle initiation and at harvest of rice crop . However, the pH and EC were not significantly differed among the P levels from 0 to 120 kg P_2O_5/ha^{-1}. The similar trend was followed in succeeding blackgram at flowering and harvest.

LITERATURE CITED

Amoah A A, Miyagawa S and Kawakubo N 2012 Effect of supplementing inorganic fertilizer with organicfertilizer on growth and yield of rice-cowpea mixed crop. *Plant Production Science.* 15 (2): 109-117.

Bationo A Ed 2007 Advances in Integrated Soil Fertility Management in sub- Saharan Africa: Challenges and Opportunities. *Springer*.

Khusbhoo S Jat H S, Meena M D, Madhu C, Mishra A K and Chaudhari S K 2016 Long term impact of different cropping systems on soil quality under silty loam soils of Indo-Gangetic plains of India. *Journal of Applied and Natural Science*. 8(2): 584-587.

Kumar V and Singh A P 2010 Long-term effect of green manuring and farm yard manure on yield and soil fertility status in rice-wheat cropping system. *Journal of the Indian Society of Soil Science*. 58(4): 409-412.

Mairan N R, Patil S G and Kachhave K G 2005 Physico-chemical properties under sorghum-sunflower cropping sequence in vertisols. *Journal of soils crops*. 15(2): 352-355.

Negassa W F Getaneh A Deressa and B Dinsa 2007 Integrated use of organic and inorganic

fertilizers for maize production. *Utilization of diversity in land use systems: Sustainable and organic approaches to meet human needs*. Pp: 9 - 11.

Pattanayak S K, Mishra K N, Jena M K and Nayak R K 2001 Evaluation of green manure crops fertilized with various phosphorus sources and their effect on subsequent rice crop. *Journal of the Indian Society of Soil Science*. 49(2): 285-291.

Rathod V E, Sagare B N, Ravankar H N, Sarap P A and Hadole S S 2003 Efficacy of amendments for improvement in soil properties and yield of cotton grown in sodic vertisols of vidarbha using alkali water. *Journal of soils and crops*, 13: 176-178.

Sarwar G, Hussain N, Schmeisky H, Suhammad S, Ibrahim M and Ahmad S 2008 Efficiency of various organic residues for enhancing rice-wheat production under normal soil conditions. *Pakistan Journal of Botany*. 40(5): 2107-2113.

Sarwar G, Schmeisky H, Hussain N, Muhammad S, Ibrahim M and Safdar E 2009 Improvement of soil physical and chemical properties with compost application in rice-wheat cropping system, *Pakistan Journal of Botany*. 40(1): 275-282.

Sharma M, Mishra B and Singh R 2007 Long-term effect of fertilizers and manure on physical and chemical properties of Mollisol. *Journal of the Indian Society of Soil Science*. 55 (4): 523-524.

Smiciklas K D, Walker P M and Kelley T R 2002 Utilization of compost (food, paper, landscape and manure) in row crop production. *Department of Agriculture and Health Sciences, Illinois State University, USA*.

Tandon H L S 2000 *Fertilizers, organic manures recyclable wastes and biofertilizers* - components of integrated plant nutrition-fertilizer development and consultation organization. 204, A Bhanot Corner, 1-2 Pampoosh Enclave. New Delhi, India.

Tesfa B, D Tolessa G Setegn T Tamado, G. Negash, and W Tenaw 2001 Development of Appropriate Cropping Systems for Various Maize Producing Regions of Ethiopia. *Second National Maize Workshop of Ethiopia*. Pp: 12-16.

Yaduvanshi N P S 2001 Effect of five years of rice-wheat cropping and NPK fertilizers use with and without organic and green manures on soil properties and crop yields in a reclaimed sodic soil. *Journal of the Indian Society of Soil Science*. 49 (4): 714-719.