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Effect of efficient nitrogen management on soil chemical properties under transplanted rice

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Abstract
A field experiment was conducted during *kharif* season of 2017 at Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.). The soil of the experimental field was well drained, loam in texture, alkaline in reaction (pH 8.12), low in available nitrogen, medium in available phosphorus and available potassium with an electrical conductivity of 0.23 dSm^{-1}. Nine treatments comprising control (No N), 120 (RDN) N through urea at basal, maximum tillering and panicle initiation, respectively or 50:25:25 N, 50:50:00 N through urea at basal, maximum tillering and panicle initiation, respectively, 25:25:50 N through urea at basal, maximum tillering and panicle initiation, respectively, 75:12.5:12.5 N through urea at basal, maximum tillering and panicle initiation, respectively, 50% N, through urea at basal, and rest through LCC, 33% N through urea at basal, rest through LCC, 50% N through urea at basal, rest through SPAD, and 33% N through urea at basal, rest through SPAD, replicated thrice estimated in a randomized block design. The experimental results revealed that the soil with highest available nitrogen, phosphorus, potassium and Organic carbon was recorded in T6 (application of 50% N through urea as basal, rest through LCC) at tillering, panicle initiation (PI) and harvesting stages respectively.

Keywords: Nitrogen, organic carbon, soil and transplanted rice

1. Introduction
Rice (*Oryza sativa* L.) is one of the world's most important food crop and India, as a major rice producer, alone contributes 30% of total area and 22% of the total production of the world. The evidence is clear that the soil's native ability to supply sufficient nutrients has decreased with the higher crop productivity levels associated with increased human demand for food. One of the greatest challenges and need of our generation will be to develop and implement soil, crop, and nutrient management technologies that enhance the quality of the soil, (Gawde *et al*., 2017) [4]. Demand for rice is growing every year and it is estimated that by 2025 AD the requirement would be 140 million tonnes to sustain present food self-sufficiency and to meet future food requirements, India has to increase its rice productivity by 3 per cent per annum. Out of 17 nutrients essential required by crop plants for their normal growth and reproduction, nitrogen (N) is generally required in the largest amounts. Urea is one of the most widely used sources of fertilizer N in the world. Soil organic N is continually lost through plant removal, leaching, DE nitrification and ammonia volatilization. An additional concern is that the capacity of soil to supply N may decline with continuous intensive rice cropping under wetland conditions, unless it is replenished by biological N fixation. More than 50 % of the N used by transplanted rice receiving fertilizer N is derived from the combination of soil organic N and BNF by free-living and rice plant-associated bacteria. The remaining N requirement is normally met with fertilizer. Thus fertilizer N recommendations must be based on the crop demand and supply capacity of the soil. Therefore, the difference between the nitrogen supply from the soil and crop need must be mitigated to increase the crop productivity as well as to maintain soil health.

2. Materials and Methods
A field experiment was conducted during *kharif* season of 2017 at Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.). The soil of the experimental field was well drained, loam in texture, alkaline in reaction (pH 8.12), low in available nitrogen, medium in available phosphorus and available potassium with an electrical

conductivity of 0.23 dS m^{-1}. Nine treatments comprising control (No N), 120 (RDN) N through urea at basal, maximum tillering and panicle initiation, respectively or 50:25:25 N, 50:50:00 N through urea at basal, maximum tillering and panicle initiation, respectively, 25:25:50 N through urea at basal, maximum tillering and panicle initiation, respectively, 75:12.5:12.5 N through urea at basal, maximum tillering and panicle initiation, respectively, 50% N, through urea at basal, and rest through LCC, 33% N through urea at basal, rest through LCC, 50% N through urea at basal, rest through SPAD, and 33% N through urea at basal, rest through SPAD, replicated thrice estimated in a randomized block design.

3. Results and Discussion

Soil pH in different treatments is shown Table1. The pH of soil (0-15 cm) varied from 7.88 to 8.12. Highest soil pH was recorded in soil sample with the application of 33% N through urea at basal, rest through LCC in T_7 and this was at par with T_9, where the application of 33% N through urea at basal, rest through SPAD. Minimum soil pH (7.88) was recorded in control. These results are in line with the findings of Doberman *et al*. (2002) [2]. At harvesting stage of rice crop, organic carbon in soil under different treatments varied from 3.73 to 4.08 g kg^{-1}. The maximum organic carbon of 4.08 g kg^{-1}, statistically at par with T_6, and T_3 and significantly higher than the remaining treatments was found in T_8, where the 50% N through urea at basal, and rest through SPAD was applied. The minimum organic carbon (3.73 g kg^{-1}) found under control was significantly lower than the remaining treatments. The organic carbon content in soil with the recommended N application schedule was highest in T_8, followed by the T_6, T_3 and T_5. Maximum organic carbon (g kg^{-1}) observed with the application of 50% N through urea as basal, rest through LCC (T_6) while, lower under control. Available nitrogen (kg ha^{-1}) in soil as affected by different fertility treatments at different stages is presented in Table 1. The available nitrogen in soil decline gradually with the advancement of crop growth in all the treatments. At tillering stage, available nitrogen in soil under different treatments `ranged from 208.43 to 238.81 kg ha^{-1}. The maximum available nitrogen (238.81 kg ha^{-1}) statistically at par with T_7, T_8, T_9, and significantly higher than the remaining treatments was found in T_6 (50% N through urea at basal, and rest through LCC). The minimum available nitrogen (208.43 kg ha^{-1}) was recorded in control (T1), which was significantly lower than the remaining treatments. The available nitrogen at tillering stage was recorded more than the panicle initiation and harvesting stage for each treatment. At Panicle initiation stage, the available nitrogen was varied from 197.61 kg ha^{-1} to 227.67 kg ha^{-1}. The maximum available nitrogen (227.67 kg ha^{-1}) were recorded in T_6 (50% N through urea at basal, and rest through LCC) was statistically at par with T_7, T_8, T_9 and significantly higher than all remaining treatments. Available nitrogen was comparatively higher than the harvesting stage and lower than the tillering stage. At harvesting stage, the available nitrogen was varied from 191.25 kg ha^{-1} to 221.24 kg ha^{-1}. The maximum available nitrogen (221.24 kg ha^{-1}) statistically at par with T_7, T_8, T_9 and significantly higher than the remaining treatments was found in T_6 where 50% N through urea at basal, and rest through LCC was applied. The minimum and significantly lower available nitrogen than the other treatments (191.25 kg ha^{-1}) was found under control followed by T_3. The use of 50% N as basal and rest through LCC also recorded significantly maximum available nitrogen as compared to the other treatments. Similar result also reported by Guan *et al*. (2011) [3] and Bitew and Alemayehu (2017) [1].

Table 1: Effect of different treatments on pH, organic carbon and available NPK at different stage in surface soil

Treatments	pH (1:2.5 Soil :H20)	Organic C at harvest stage (g kg^{-1})	Available nitrogen (kg ha^{-1})			Available phosphorus (kg ha^{-1})			Available potassium (kg ha^{-1})		
			Tillering stage	P.I. stage	Harvesting stage	Tillering stage	P.I. stage	Harvesting stage	Tillering stage	P.I. stage	Harvesting stage
T_1	7.88	3.73	208.43	197.61	191.25	**10.12**	10.51	9.01	174.08	170.18	150.52
T_2	7.94	3.83	230.13	219.53	210.81	12.34	13.73	11.21	220.21	205.40	189.33
T_3	7.94	3.99	226.49	215.18	207.01	12.06	13.48	11.82	222.68	207.00	190.50
T_4	8.03	3.81	231.09	220.72	212.27	12.52	13.49	11.35	221.91	201.41	186.87
T_5	8.00	3.92	231.09	218.47	208.91	12.13	13.52	11.07	217.50	197.67	183.40
T_6	7.89	4.01	238.81	227.67	221.24	13.52	14.54	12.85	231.39	216.63	195.97
T_7	8.12	3.90	233.74	223.14	216.81	12.74	13.21	12.00	228.86	214.47	193.07
T_8	8.05	4.08	232.53	221.84	215.10	12.57	13.65	11.88	227.30	214.19	192.25
T_9	8.12	3.89	236.04	225.18	218.47	12.91	13.75	12.19	230.95	215.63	194.57
SEm±	0.08	0.05	3.11	3.85	3.75	0.98	0.82	0.82	2.5	1.86	1.75
CD at 5%	0.23	0.15	9.05	11.18	10.89	NS	NS	NS	7.57	5.64	5.29

Available phosphorus (kg ha^{-1}) in soil as affected by different treatments at different stages of rice is presented in Table1. It is evident from the Table 1 that the available phosphorus in soil decline gradually with the advancement of crop growth in all the treatments. At tillering stage, available phosphorus in soil under different treatments varied from 10.12 to 13.52 kg ha^{-1}. The maximum available phosphorus (13.52 kg ha^{-1}) was recorded in T_6, which was non-significant effect between the all treatments. The minimum available phosphorous (10.12 kg ha^{-1}) were recorded in control (T_1), which was non-significant effect between the treatments. At Panicle initiation stage, available phosphorus in soil under different treatments varied from 10.51 to 14.54 kg ha^{-1}. The maximum available phosphorus (14.54 kg ha^{-1}) found in T_6, which was non-significant effect between the treatments. The minimum available phosphorus (10.51 kg ha^{-1}) found in T_1, which was show non-significant effect to all treatments. At harvesting stage, available phosphorus in soil under different treatments varied from 9.01 to 12.85 kg ha^{-1}. The maximum available phosphorus (12.85 kg ha^{-1}) found in T_6 followed by T_9, which was non-significant effect on all treatments. Minimum available phosphorus (9.01 kg ha^{-1}) was found under control (T_1) was non-significant lower than all the remaining treatments. Highest available phosphorus at maximum tillering and PI stage could be ascribed to higher organic matter content in this treatment, which may reduce the fixation of phosphate by providing protective cover on sesqueoxides and chelating cations responsible for fixation by

Singh *et al.,* (2008) [6] and Kumar *et al.* (2015) [5] also reported similar results. Available potassium (kg ha^{-1}) in soil as affected by different treatments at various stages of rice is presented in Table 1. The available potassium in soil decline gradually with the advancement of crop growth in all the treatments. At tillering stage, available potassium in soil under different treatments varied from 174.08 to 231.39 kg ha^{-1}. The maximum available potassium (231.39 kg ha^{-1}), statistically at par with T_7, T_8, T_9 and significantly higher than the remaining treatments was found in T6 (50% N, through urea as basal, and rest through LCC). The minimum available potassium (174.08 kg ha^{-1}) found under control was significantly lower than all the remaining treatments. The Available potassium in soil was found significant lowest in control, which was lower than the T_2, T_3, T_4 and T_5. At Panicle initiation stage, available potassium in soil under different treatments varied from 170.18 to 216.63 kg ha^{-1}. The maximum available potassium (216.63 kg ha^{-1}) were recorded in T_6 (50% N through urea as basal and rest through LCC) was statistically at par with T_7, T_8 and T_9 higher than the remaining treatments. Minimum available potassium (170.18 kg ha^{-1}) found under control, which was the significantly lower than the T_2, T_3, T_4 and T_5. Potassium availability of approximately similar significantly in the T_7 (33% N through urea as basal, rest through LCC) and T_8 (50% N through urea at basal, rest through SPAD). At harvesting stage, the maximum available potassium (195.97 kg ha^{-1}) recorded, which was statistically at par with T_7, T_8 and T_9 significantly higher than the remaining treatments were found in T_6 (50% N, through urea as basal, and rest through LCC). Minimum available potassium (150.52 kg ha^{-1}) was found in T_1, which was significant lower than the all treatments. Availability of potassium approximately similar in the T_2 (120 (RDN) through urea at basal, maximum tillering and panicle initiation, respectively) and T_3 (50:50:00 N through urea at basal, maximum tillering and panicle initiation, respectively). The improvement in K was might be due to slow and steady supply of potassium due to solubilization effect of organic acid produced during decomposition processes by Singh *et al*., (2008) [6].

4. Conclusion

On the basis of experimental findings, it can be concluded that highest available nitrogen, phosphorus, potassium and Organic carbon in soil was recorded in T_6 (application of 50% N through urea as basal, rest through LCC) at tillering, panicle initiation and harvesting stages respectively. Therefore application of 50% N through urea as basal, rest through LCC was better option for N management strategies to improve soil chemical properties under transplanted rice.

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