

Original Research Article

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Study of Electrochemical Properties of Soil and Nutrient Status of Rice and Maize based Cropping Sequences in Central Plain Zone of Uttar Pradesh

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ABSTRACT

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An experiment was executed with ten crop sequences during 2010-17 at C.S. Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh under All India Coordinating Research Project on Cropping systems. All these sequences were evaluated for their soil electrochemical and nutrient analysis. Results revealed that improvement in soil electrochemical properties (pH, EC and OC) and available NPK content after harvest was achieved by Hyb. Rice-wheat-green gram (G+R) among four rice based cropping sequences, while these were achieved by Maize-garlic-green gram (G+R) cropping sequence among six maize based cropping sequences. Maximum available nitrogen, phosphorus and potassium status (263, 14.90 and 223 kg/ha respectively) after harvest were recorded in Hyb. Rice-wheat-green gram (G+R) among rice based cropping sequences and among maize based cropping sequences, Maize-garlic- green gram (G+R) showed maximum available N, P and K of 259.2, 14.5 and 222 kg/ha respectively.

Introduction

Cropping system signifies the sequence of crops grown over a specific piece of cultivated land and to increase the benefits from the available resources. Therefore, the basic approach in an efficient cropping system is to increase production and economic returns (Yadav *et al.*, 1998). A flexible cropping system helps in capturing economic opportunities and environmental realities (Gangwar *et al.*, 2004) and in ensuring balanced farm growth at regional level (Reddy and Suresh 2009). Hence, selection of component crops needs to be suitably planned for efficient utilization of resource base and to

increase overall productivity (Anderson, 2005). Higher annualized crop yields increase nutrient removal, which must be balanced by increased nutrient inputs to ensure optimal crop yield and quality while avoiding soil depletion. Furthermore, diversification of crops alters the pattern and degree of nutrient removal and influences microbiological activity and soil quality. Although cropping intensification and diversification will influence most plant nutrients, N and P are the nutrients most commonly deficient for crop production in the Plains and most likely to be affected by management practices. Cropping intensification increases crop residue return to the soil, which in turn increases the soil

organic C pool. This can lead to higher soil organic matter levels and a greater potential for nutrient cycling, an effect that will increase with time. Cropping systems that include legumes have the potential for contributing N to following crops and may moderate NO₃ levels in the soil to avoid potential for NO₃ leaching. Phosphorus availability may be influenced by depletion or accumulation of P, based on past cropping and fertilizer management. In addition, preceding crop may influence P availability through residue effects and impacts on vesicular-arbuscular mycorrhizae activity. Synchrony of nutrient supply with crop demand is essential in order to ensure optimum crop yield and quality while avoiding negative environmental impacts.

It has been widely reported that most soils of the Indo-Gangetic Plain (IGP) have high K status due to continuing additions from rainfall, irrigation water, and release from K-rich clay minerals (Dobermann *et al.*, 1996a, 1996b, 1999). Several studies have shown, however, that intensive rice-based cropping systems, including rice-wheat (RW) (Timsina and Connor, 2001), may cause heavy depletion of soil NPK (BijaySingh *et al.*, 2003; Yadvinder- Singh *et al.*, 2005).

Extraction is especially large in these systems because straw is often harvested as well as grain, or is burnt to facilitate tillage (Timsina and Connor, 2001). Harvested straw finds important use in thatching, fuel, and animal fodder. Recent soil tests now show that many soils of the IGP, with available NPK concentrations are becoming deficient in soils despite originally high contents (Dobermann *et al.*, 1999; Regmi *et al.*, 2002; Srivastava *et al.*, 2002; Bijay-Singh *et al.*, 2003). Depletion of soil nutrients, NPK, is a possible cause of yield decline in long-term RW experiments in northwest India (Bhandari *et al.*, 2003) and Nepal (Regmi *et al.*, 2002).

Rice –wheat cropping system (RWCS) is the world's largest agricultural production system occupying around 12.3 m ha in India and around 85 percent of this area falls in Indo-Gangetic plains (IGP) (Ladha *et al.*, 2003; Timsina and Connor, 2001). This system requires high input resources for higher productivity resulted higher cost per unit area and time. Following continuously the same system has adverse effect on soil health, ultimately decline in factor productivity of the system (Kumar and Yadav, 1993). So, diversification has been envisaged as a new strategy for enhancing and stabilizing productivity and soil health, making Indian agriculture competitive and increasing net farm income and economic security toward achieving the sustainable agricultural development. Both Rice-Wheat and Maize-Wheat cropping systems are predominately practiced under irrigated as well as rainfed production system in Indo-Gangetic Plains. As a whole, cultivation of both rice and wheat crop is costly time consuming, energy exhaustive and tedious. Hence, there is an urgent need for diversification and intensification of cropping system in rice based cropping system by improving the productivity and profitability per unit area per unit time without jeopardizing the soil health. The inclusion of crops like oil seeds, pulse and vegetable will improve the economic condition of the farmers owing to higher price and higher volume of their main and by-products. The legumes will also show favourable effect on soil health (Kharub *et al.*, 2003).

Materials and Methods

The field experiment was conducted during 2010-17 at Student's Instructional Farm, C.S. Azad university of Agriculture and Technology, Kanpur under All India Coordinating Research Project on Cropping Systems to study the effect of rice and maize

based cropping systems on soil fertility and soil electrochemical properties. The soil was neutral to slightly alkaline of alluvial type having pH 7.8, EC 0.18 ds m^{-1} , 0.55 % organic carbon, available nitrogen (223 kg ha^{-1}), low in available phosphorus (14 kg ha^{-1}) and medium in available potash (216 kg ha^{-1}). A total of ten cereal based crop (four rice based and six maize based) Rice-wheat (T₁), Hyb. Rice-wheat (T₂), Hyb. Rice-wheat-green gram (G+R) (T₃), Maize-wheat (T₄), Maize-mustard-onion (T₅), Maize-mustard-green gram (G+R) (T₆), Maize + green gram-potato-wheat (T₇), Maize + black gram-potato-onion (T₈) Maize-garlic-green gram (G+R) (T₉) and Scented rice-wheat-okra (T₁₀) sequences were tested. Before sowing, soil pH, EC, OC, available N, P and K content were recorded by their respective procedures. After harvest of each cropping sequence, soil samples were tested for nutrient removal by respective cropping sequence and how the

electrochemical properties of soil were affected.

Results and Discussion

Effect on soil electrochemical properties (after harvest)

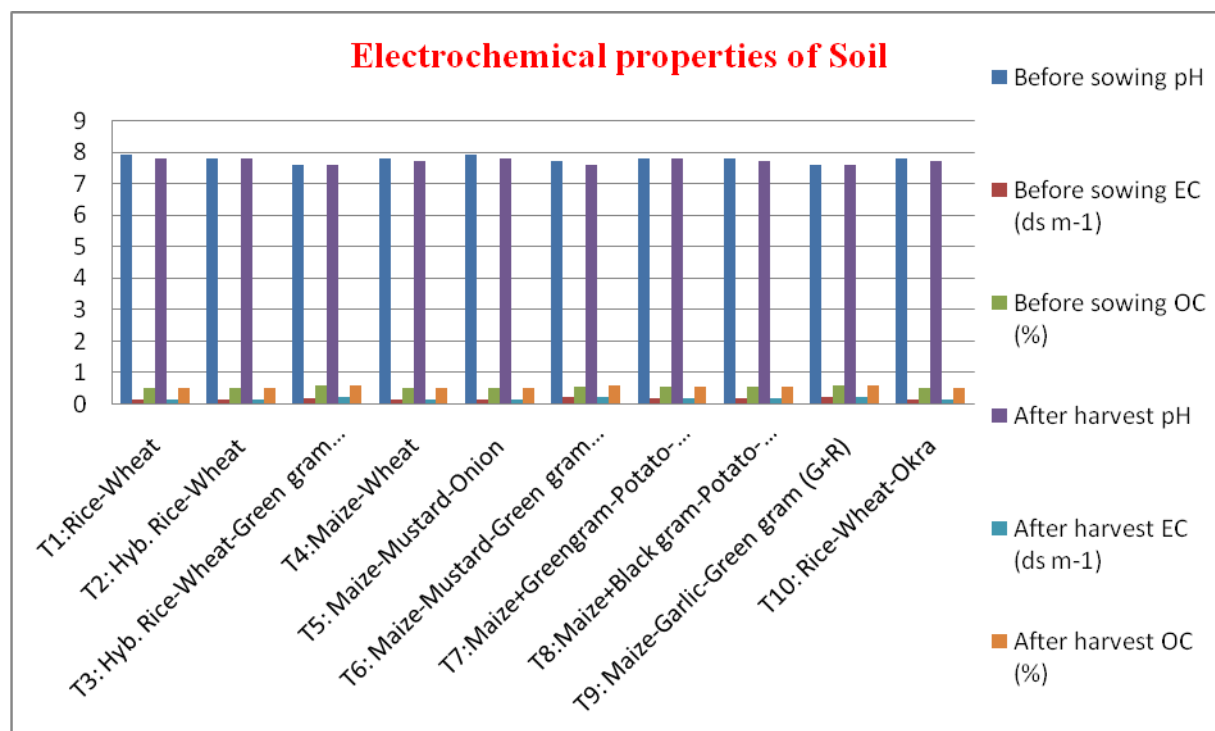
The data presented in the Table 1, indicates that soil electrochemical properties (pH, EC and OC) after harvest of ten cereal based cropping sequences in Central Plain Zone of Uttar Pradesh. There was a little change in soil pH i.e. 0.1 unit either less or more in all crop sequences. EC was also changed slightly i.e. 0.01 units either less or more in all crop sequences. OC % was improved well in crop sequences having green gram/black gram crop as a component crop of the crop sequence. Almost all crop sequences recorded improvement in soil organic carbon (Porpavai *et al.*, 2011).

Table.1 Electrochemical properties of soil

Cropping Sequence	Before sowing			After harvest		
	pH	EC (ds m^{-1})	OC (%)	pH	EC (ds m^{-1})	OC (%)
T₁:Rice-Wheat	7.9	0.16	0.51	7.8	0.15	0.52
T₂: Hyb. Rice-Wheat	7.8	0.15	0.53	7.8	0.15	0.54
T₃: Hyb. Rice-Wheat-Green gram (G+R)	7.6	0.22	0.60	7.6	0.23	0.62
T₄:Maize-Wheat	7.8	0.16	0.52	7.7	0.16	0.53
T₅: Maize-Mustard-Onion	7.9	0.17	0.51	7.8	0.17	0.52
T₆: Maize-Mustard-Green gram (G+R)	7.7	0.23	0.58	7.6	0.24	0.60
T₇:Maize+Greengram-Potato-Wheat	7.8	0.20	0.55	7.8	0.21	0.56
T₈:Maize+Black gram-Potato-Onion	7.8	0.21	0.56	7.7	0.22	0.57
T₉: Maize-Garlic-Green gram (G+R)	7.6	0.23	0.59	7.6	0.24	0.61
T₁₀: Rice-Wheat-Okra	7.8	0.16	0.51	7.7	0.15	0.53

Table.2 Soil available nutrient status

Cropping Sequence	Before sowing			After harvest		
	Avail. N (kg/ha)	Avail. P (kg/ha)	Avail. K (kg/ha)	Avail. N (kg/ha)	Avail. P (kg/ha)	Avail. K (kg/ha)
T₁:Rice-Wheat	216.7	13.8	213	221.0	13.8	214
T₂: Hyb. Rice-Wheat	225.2	14.5	215	229.5	13.5	217
T₃: Hyb. Rice-Wheat-Green gram (G+R)	255.0	14.8	221	263.5	14.9	223
T₄:Maize-Wheat	221.0	13.6	211	225.2	13.7	212
T₅: Maize-Mustard-Onion	216.7	13.5	214	221.0	13.4	215
T₆: Maize-Mustard-Green gram (G+R)	246.5	14.2	219	255.0	13.3	221
T₇:Maize+Greengram-Potato-Wheat	233.7	13.8	215	238.0	13.6	216
T₈:Maize+Black gram-Potato-Onion	238.0	14.0	217	242.2	14.1	218
T₉: Maize-Garlic-Green gram (G+R)	250.7	14.4	220	259.2	14.5	222
T₁₀: Rice-Wheat-Okra	216.7	13.6	213	225.2	13.7	215
SEM ±	12.02	0.44	7.67	12.82	0.47	7.85
CD (P=0.05)	34.97	1.28	22.24	37.20	1.37	22.79



Effect on available nutrient status in soil (after harvest)

Improvement in available nitrogen, phosphorus and potassium status was also observed in all crop rotations in comparison to initial values. Maximum available nitrogen status (263 kg/ha) was recorded in Hyb. Rice-wheat-greengram (G+R) (T₃) followed by Maize-garlic- greengram (G+R) (T₉). Maximum available phosphorus status (14.90 kg/ha) was recorded in Hyb. Rice-wheat-greengram (G+R) (T₃) followed by Maize-garlic- greengram (G+R) (14.55 kg/ha) (T₉). Maximum available phosphorus status (223 kg/ha) was recorded in Hyb. Rice-wheat-greengram (G+R) (T₃) followed by Maize-garlic- greengram (G+R) (222 kg/ha) (T₉). Porpavai *et al.*, (2011) also reported that inclusion of legumes in cropping system improved soil available NPK (Table 2).

The fertility status of the soil indicated beneficial impact of crop diversification/intensification on soil fertility. Its effect was more pronounced in the case of Hyb. Rice-wheat- greengram (G+R) among rice based cropping sequence, while Maize-garlic-greengram (G+R) in the case of maize based cropping sequence.

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