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Depth Wise Variability of Available N, P and K at Different Locations under Rice - Pea- Sugarcane Cropping System in Meerut District (U.P)

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ABSTRACT

Background: The research is based on the fertility status of the soil being affected year by year so here is a strategy to save the soil fertility level or soil health by the use of a leguminous cropping system.

Methods: A study was conducted during 2018-2021 in the Meerut district of western Uttar Pradesh to evaluate the soil characterization of the rice - pea- sugarcane cropping system. The soil samples were analyzed for various parameters in the laboratory. The status of available NPK in soils and other soil properties like pH, electrical conductivity (EC) and organic carbon (OC) content were assessed.

Result: Results reveal that the soils of the study area were neutral to strongly alkaline in reaction and non-saline in nature. Nutrient status regarding to the available nutrient in the surface (0-15 cm) and subsurface (15-30 cm) depth of soil indicate that soils are low in available N and medium in available P and K in surface and subsurface. A positive and significant correlation of NPK with organic matter content was found while significant and negative correlations exist between the soil pH.

Key words: Fertilizer, Pea, Rice, Soil.

INTRODUCTION

Cropping systems are designed and managed to grasp human goals so that they are purposeful systems. It includes every spatial and sequential aspect of managing an agricultural system. Cropping system-level study isn't only useful to know the overall sustainability of the agricultural system, but also it helps in generating many important parameters which are useful in global climate change impact assessment. Within the past, cropping systems were designed to maximize yield, but modern agriculture is progressively more concerned with promoting environmental sustainability in cropping systems.

The major cropping systems in western IGP (Indo-Gangetic Plane) are rice-wheat, sorghum-wheat, cotton-wheat, pearl millet-rapeseed and mustard, maize-wheat, sugarcane-wheat, pigeon pea-wheat, groundnut-wheat, rice-pea, rice-mustard/potato-black gram/mung bean. However, rice-wheat is that the predominant cropping system, occupying about 10 million ha. Soil fertility management becomes more complex in intensive cropping thanks to the residual effect of nutrients applied to the previous crops, a possible effect of legumes within the system, complementary and competitive interaction from the component crops and influence of crop residues left within the soil. The fashionable or chemical agriculture, which contains higher cropping intensity involving improved varieties, heavier inputs of fertilizer and water, increasing yields and accelerated removal of plant nutrients has added newer dimensions to fertility management. Nutrient removal under different cropping systems could even be variable since it depends on rooting pattern, the extent of biomass production and superior absorption of the nutrient. Supported future fertility experiments conclusions that various parts of India, application of N at recommended dose is an advocate to every of the crop in a cropping system. Phosphorus management in cropping systems needs careful adjustment of P fertilizer dose taking into account reasonably fertilizer, soil characteristics and their yield level, the extent of P removal and growing environment. In a cropping system-involving wheat, fertilizer P dose to Kharif crop could even be reduced if preceding wheat has received P in adequate amounts. Removal of K in proportion to N is incredibly high in cropping systems particularly those involving cereal and fodder crops. It's important to use K fertilizer at the recommended dose to care for soil fertility. The nonstop practice of cereal-cereal rotations within the Indo-Gangetic

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Plains (IGP) of India has caused a nutrient imbalance, soil degradation and intensive pest pressure (Ladha *et al*. 2003; Chauhan *et al*., 2012). This successively deteriorates crop productivity within the region, a trend that's increasingly evident within the IGP. With growing access to irrigation facilities, farmers within the IGP region have shown a higher preference input-responsive cereals than other crops (particularly pulses); thereby aggravating the issues related to low crop diversification (Ali and Gupta 2012). In comparison to rice-wheat and rice-fallow cropping systems, soils in rice-legume crop cycles with high input and diversity of organic materials have been found to contain higher concentrations of microbial biomass and enzymes. In the current situation, an intense cropping system that is not only highly productive and profitable but also stable over time and maintains soil fertility is crucial. The inclusion of pulses, oilseeds and vegetables is more helpful than cereal following cereal in the system. Furthermore, legumes are said to have a positive impact on soil fertility and aid in enhancing the production of subsequent rice crops.

MATERIALS AND METHODS

The study area falls in the Meerut district of western Uttar Pradesh. The area is situated at a latitude of 29° 40′ North and longitude of 77° 42′ East with an elevation of 237 m above mean sea level. Soil samples from two depths (0-15 and 15-30 cm) from 48 locations with the use of GPS of Meerut district under different cropping patterns were collected with the help of an auger and stored in polythene bags. Collected soil samples were air-dried in shade crushed gently with a wooden roller and then pass through a 2.0 mm sieve to obtain a uniform representative sample. Samples were properly labeled with the aluminum tag and stored in polythene bags for analysis. The processed soil samples were analyzed by standard methods for pH and electrical conductivity (1:2 soil water suspensions), organic matter (Walkley and Black, 1934), available nitrogen (Subbiah and Asija, 1956), available phosphorus, available potassium (Jackson, 1973). All the analytical work was carried out in the laboratory of the Department of Soil Science, SVPUA and Tech, Meerut (U.P), India.

RESULTS AND DISCUSSION

The availability of N, P and K after harvesting of rice- pea cropping system the analysis was done which show some changing in soil properties. Data regarding the soil pH of surface and subsurface are presented in (Table 1). The soil samples of surface and subsurface were usually found normal to alkaline reaction and it varied from 7.21 to 8.10 and 7.25 to 8.12, respectively (Table 2). A similar finding was observed by Rajeswar *et al*. (2009). The minimum pH of 7.21 at the surface was observed in the Alamgirpur village of the Parikshitgarh block, while the maximum pH of 8.10 was observed in Lawar Khas village of Daurala block. Similarly, in the subsurface, minimum pH 7.25 and maximum pH 8.12 were observed at both the same locations. Data presented in Table 2 shows that about 2.08% of the soil samples were found to be neutral, 54.17% were slightly alkaline and 43.75% was moderately alkaline at surface soil while at subsurface 2.08% of the soil samples were found to be saline, 41.66% were slightly alkaline and 56.25% were moderately alkaline. (Neutral: 6.6-7.3, Slightly alkaline: 7.4-7.8, Moderately alkaline: 7.9-8.4) This may be due to the influence of parent material, rainfall and topography (Thangaswamy *et al.,* 2005). In other soil properties, electrical conductivity was also observed that the electrical conductivity of surface and subsurface soil varied from 0.17 to 0.56 dSm^{-1} and 0.26 to 0.48 dSm^{-1}, respectively. Based on the limits suggested by Muhar *et al*. (1963) for judging the salt problem of soils, most of the samples were found normal (EC).

The organic carbon content in soil at the surface (0-15 cm) ranged from 0.30 to 0.51 per cent with a mean value of 0.38 per cent, while at subsurface (15-30 cm), ranged from 0.19 to 0.42 per cent with a mean value of 0.28 per cent (Table 2) The highest organic carbon (0.51 per cent) was found in Sultannagar location and minimum (0.30 per cent) in Daurala location for surface soil (0-15 cm), while in subsurface soil (15-30 cm), maximum organic carbon (0.42 per cent) in Sultannagar location and minimum (0.19 per cent) in Daurala location was recorded. Based on the rating suggested by Singh *et al*. (2005), Most of the soil samples were low in organic carbon status at the surface, while subsurface soil was also low in organic carbon.

The available nitrogen content in surface (0-15 cm) and subsurface (15-30 cm) soils varied from 169.98 to 255.90 kg ha^{-1} and 107.89 to 180.13 kg ha^{-1}, respectively (Table 3). The maximum available nitrogen 255.90 and 180.13 kg ha^{-1} at surface and subsurface was found in Sultannagar village of Sururpur block and minimum 169.98 and 107.89 kg ha^{-1} village Lawar Khas. Based on the rating suggested by Subbiah and Asija (1956) 97% of samples were low (<250 N kg ha^{-1}) and 3% of samples were medium (250-500 N kg ha^{-1}). Available nitrogen content was found to be maximum in surface horizons and decrease regularly with

Table 1: Correlation studies between OM and pH with available N, P and K under different locations.

	0-15 cm depth		15-30 cm depth	
	pH	O.C	pH	O.C
pH	1.00		1.00	
O.C	-0.211^{NS}	1.00	-0.230^{NS}	1.00
Avail. N	-0.243^{NS}	0.952**	-0.236^{NS}	0.983**
Avail. P	-0.176^{NS}	0.658**	-0.185^{NS}	0.973**
Avail. K	-0.238^{NS}	0.960**	-0.303^{NS}	0.795**

*Significant (p=0.05).

OC significantly and positively correlated with the above discussed soil properties (r = 0.952, 0.658, 0.960 and subsurface, r = 0.983, 0.973 and 0.795 respectively).

The analysis indicates that pH was negatively correlated with Available N, P and K in surface (0-15 cm) and subsurface (15-30 cm).

Table 2: Depth wise pH, O.C (%) and E.C (dS m^{-1}) of different location soil under rice- pea- sugarcane cropping system.

Location		Cropping system (Rice - pea - sugarcane) and depth (cm)								
Blocks name	Village name	pH			O.C (%)			E.C dS m^{-1}		
		0-15	15-30	Mean	0-15	15-30	Mean	0-15	15-30	Mean
Daurala	Lawar Khas	8.10	8.12	8.11	0.31	0.19	0.25	0.17	0.29	0.23
	Lawar Khas	7.48	7.48	7.48	0.30	0.19	0.25	0.35	0.31	0.33
	Akhtyarpur	7.79	7.81	7.80	0.30	0.20	0.25	0.42	0.48	0.45
	Chindauri	7.80	7.80	7.80	0.44	0.35	0.40	0.32	0.42	0.37
Shardhana	Chabariya	8.03	8.03	8.03	0.32	0.22	0.27	0.37	0.34	0.36
	Begumabad	7.47	7.48	7.47	0.34	0.24	0.29	0.31	0.33	0.32
	Milak	7.57	7.58	7.57	0.32	0.22	0.27	0.29	0.26	0.28
	Teherkiya	8.08	8.10	8.09	0.42	0.32	0.37	0.37	0.35	0.36
Sururpur	Saroorpur Khurd	7.87	7.89	7.88	0.36	0.26	0.31	0.36	0.41	0.39
	Kheri Kalan,	7.70	7.71	7.70	0.32	0.22	0.27	0.31	0.36	0.34
	Harar	7.49	7.49	7.49	0.38	0.27	0.33	0.32	0.29	0.31
	Sultannagar	7.48	7.50	7.49	0.51	0.42	0.47	0.32	0.40	0.36
Rohta	Rasulpur	7.94	7.95	7.94	0.41	0.31	0.36	0.30	0.33	0.32
	Rasna	7.46	7.46	7.46	0.48	0.38	0.43	0.38	0.29	0.34
	Bhadaura	7.74	7.75	7.74	0.39	0.29	0.34	0.32	0.35	0.34
	Rasulpur Marhi	7.98	7.99	7.98	0.34	0.24	0.29	0.39	0.41	0.40
Kharkhoda	Mundali	7.80	7.81	7.80	0.38	0.28	0.33	0.42	0.37	0.40
	Salempur	7.46	7.48	7.47	0.39	0.30	0.35	0.48	0.44	0.46
	Phaphunda	7.48	7.49	7.48	0.46	0.36	0.41	0.56	0.39	0.48
	Khandawali	7.98	8.01	7.99	0.40	0.30	0.35	0.49	0.48	0.49
Hashtinapur	Palra	7.98	7.98	7.98	0.31	0.21	0.26	0.39	0.36	0.38
	Tarapur	7.45	7.46	7.45	0.31	0.22	0.27	0.38	0.43	0.41
	Pali	7.80	7.81	7.80	0.41	0.31	0.36	0.29	0.37	0.33
	Ikwara,	7.79	7.81	7.80	0.41	0.30	0.36	0.34	0.29	0.32
Jani	Afjal Pur Pawti	7.79	7.79	7.79	0.38	0.28	0.33	0.32	0.38	0.35
	Pathanpura	7.82	7.83	7.82	0.34	0.26	0.30	0.31	0.33	0.32
	Khanpur	7.79	7.80	7.79	0.48	0.37	0.43	0.30	0.32	0.31
	Timkeya	7.67	7.68	7.67	0.32	0.23	0.28	0.28	0.38	0.33
Rajpura	Shikhera	8.05	8.08	8.06	0.31	0.20	0.26	0.39	0.32	0.36
	Mohiuddinpur	7.96	7.96	7.96	0.41	0.31	0.36	0.36	0.38	0.37
	Uldeypur	7.68	7.68	7.68	0.34	0.26	0.30	0.31	0.29	0.30
	Mamepur	7.96	7.96	7.96	0.41	0.31	0.36	0.36	0.34	0.35
Meerut	Hajipur	7.95	7.95	7.95	0.39	0.29	0.34	0.36	0.31	0.34
	Gagol	8.03	8.04	8.03	0.46	0.37	0.42	0.36	0.28	0.32
	Azizpur	7.95	7.95	7.95	0.32	0.22	0.27	0.29	0.41	0.35
	Shakarpur	7.68	7.69	7.68	0.43	0.32	0.38	0.32	0.27	0.30
Parikshitgarh	Ahmadnagar Badhla	7.81	7.82	7.81	0.40	0.30	0.35	0.44	0.41	0.43
	Alamgirpur Badhla	7.21	7.25	7.23	0.42	0.32	0.37	0.33	0.40	0.37
	Chitwana Sherpur	7.51	7.52	7.51	0.34	0.25	0.30	0.39	0.38	0.39
	Poothi	7.82	7.82	7.82	0.43	0.34	0.39	0.34	0.33	0.34
Machara	Hasanpur	7.40	7.42	7.41	0.48	0.39	0.44	0.44	0.41	0.43
	Bharolli	7.76	7.77	7.76	0.42	0.33	0.38	0.36	0.37	0.37
	Amarpur	7.97	7.98	7.97	0.31	0.21	0.26	0.34	0.33	0.34
	Alipur Alampur	7.65	7.65	7.65	0.44	0.34	0.39	0.33	0.37	0.35
Mavana	Amroli	7.66	7.68	7.67	0.43	0.33	0.38	0.36	0.33	0.35
	Bhainsa	7.90	7.92	7.91	0.41	0.32	0.37	0.31	0.35	0.33
	Bhagawanpur	7.94	7.96	7.95	0.40	0.30	0.35	0.29	0.40	0.35
	Rahawati	7.83	7.85	7.84	0.31	0.20	0.26	0.30	0.31	0.31
	Mean	7.76	7.77	-	0.38	0.28	-	0.35	0.36	-

Table 3: Depth wise availability of N, P and K (kg/ha) of different location soil under rice -pea - sugarcane cropping system.

Location		Cropping system (Rice - pea - sugarcane) and depth (cm)								
Blocks name	Village name	Available N (kg/ha)			P (kg/ha)			K (kg/ha)		
		0-15	15-30	Mean	0-15	15-30	Mean	0-15	15-30	Mean
Daurala	Lawar Khas	174.89	107.89	141.39	17.89	13.71	15.80	170.66	106.23	138.45
	Lawar Khas	169.98	109.89	139.94	16.82	12.21	14.52	182.63	110.11	146.37
	Akhtyarpur	185.89	109.97	147.93	18.23	13.73	15.98	184.94	113.47	149.21
	Chindauri	246.44	166.54	206.49	31.51	21.12	26.32	235.20	165.36	200.28
Shardhana	Chabariya	202.42	128.63	165.53	21.22	15.51	18.37	201.80	112.21	157.01
	Begumabad	208.00	134.21	171.11	24.32	16.00	20.16	204.32	116.86	160.59
	Milak	201.23	125.54	163.39	24.45	15.35	19.90	193.20	110.86	152.03
	Teherkiya	234.10	157.89	196.00	29.67	18.99	24.33	227.50	130.60	179.05
Sururpur	Saroorpur Khurd	211.78	138.88	175.33	28.16	16.82	22.49	209.86	140.60	175.23
	Kheri Kalan,	203.68	128.88	166.28	25.83	15.57	20.70	203.32	125.96	164.64
	Harar	213.25	141.87	177.56	24.44	14.86	19.65	210.76	136.02	173.39
	Sultannagar	255.90	180.13	218.02	33.66	21.98	27.82	248.56	185.12	216.84
Rohta	Rasulpur	227.31	155.27	191.29	27.63	18.36	23.00	221.50	125.87	173.69
	Rasna	252.13	171.13	211.63	27.42	21.98	24.70	238.72	152.00	195.36
	Bhadaura	216.78	144.10	180.44	22.89	17.44	20.17	214.08	122.22	168.15
	Rasulpur Marhi	207.86	133.54	170.70	26.94	15.88	21.41	203.52	116.86	160.19
Kharkhoda	Mundali	216.00	143.89	179.95	23.76	17.38	20.57	213.43	121.53	167.48
	Salempur	217.63	145.06	181.35	28.47	17.51	22.99	214.54	123.31	168.93
	Phaphunda	246.74	167.06	206.90	28.10	21.34	24.72	235.20	162.45	198.83
	Khandawali	217.68	145.73	181.71	21.98	17.76	19.87	218.40	123.65	171.03
Hashtinapur	Palra	189.96	119.89	154.93	23.16	14.90	19.03	189.87	105.75	147.81
	Tarapur	201.12	125.32	163.22	19.74	15.12	17.43	192.87	110.60	151.74
	Pali	220.34	150.13	185.24	22.76	18.10	20.43	218.68	125.31	172.00
	Ikwara,	220.21	149.59	184.90	28.48	18.05	23.27	218.68	150.76	184.72
Jani	Afjal Pur Pawti	215.20	143.23	179.22	28.16	17.35	22.76	212.54	120.77	166.66
	Pathanpura	209.95	136.76	173.36	27.38	16.36	21.87	205.45	139.51	172.48
	Khanpur	247.56	170.21	208.89	32.12	21.54	26.83	235.20	136.83	186.02
	Timkeya	207.65	132.42	170.04	26.87	15.88	21.38	203.52	136.66	170.09
Rajpura	Shikhera	188.16	114.9	151.53	21.10	13.94	17.52	184.94	116.10	150.52
	Mohiuddinpur	223.32	152.43	187.88	28.50	18.22	23.36	220.32	139.84	180.08
	Uldeypur	210.12	137.65	173.89	27.72	16.74	22.23	206.44	134.61	170.53
	Mamepur	224.78	153.32	189.05	26.52	18.35	22.44	220.32	141.48	180.90
Meerut	Hajipur	216.82	144.76	180.79	28.47	17.49	22.98	214.08	123.09	168.59
	Gagol	247.32	167.77	207.55	22.17	21.47	21.82	235.20	136.80	186.00
	Azizpur	204.60	132.32	168.46	22.43	15.57	19.00	203.34	128.48	165.91
	Shakarpur	240.40	162.18	201.29	31.13	19.00	25.07	231.56	148.66	190.11
Parikshitgarh	Ahmadnagar Badhla	218.23	146.98	182.61	26.74	17.89	22.32	218.60	124.77	171.69
	Alamgirpur Badhla	233.43	157.84	195.64	22.78	18.91	20.85	224.54	147.16	185.85
	Chitwana Sherpur	208.90	135.43	172.17	27.38	16.15	21.77	204.35	136.48	170.42
	Poothi	240.40	163.78	202.09	31.13	19.65	25.39	231.56	151.70	191.63
Machara	Hasanpur	254.23	178.10	216.17	32.21	21.98	27.10	246.40	139.11	192.76
	Bharolli	238.32	162.43	200.38	29.84	19.04	24.44	228.36	157.3	192.83
	Amarpur	194.87	121.45	158.16	23.50	15.07	19.29	189.98	105.86	147.92
	Alipur Alampur	243.44	165.78	204.61	28.94	20.43	24.69	234.56	156.72	195.64
Mavana	Amroli	238.45	163.24	200.85	27.76	19.05	23.41	228.36	132.75	180.56
	Bhainsa	232.20	156.87	194.54	26.71	18.89	22.80	224.00	138.70	181.35
	Bhagawanpur	218.54	148.72	183.63	18.98	18.01	18.50	218.60	141.76	180.18
	Rahawati	189.87	115.79	152.83	22.91	14.57	18.74	188.95	103.20	146.08
	Mean	218.50	144.70	-	25.81	17.53	-	213.82	131.92	-

soil depth,which might be due to the accumulation of plant residues, debris at the surface which contributed through mineralization. These observations are following the findings of Prasuna Rani *et al*. (1992). Correlation studies show that a significant positive correlation was found between organic carbon and available nitrogen. This might be because most of the soil nitrogen is found in organic forms. Similar results were also reported by Kanthalia and Bhatt (1991); Paliwal (1996).

The available phosphorus (P_2O_5) in the surface (0-15 cm) and subsurface (15-30 cm) varied from 16.82 to 33.66 and 12.21 to 21.98 kg ha^{-1} P_2O_5, respectively (Table 3). The maximum available phosphorus 33.66 kg ha^{-1} P_2O_5 was found in Sultannagar village of Sururpur block and minimum 16.82 P_2O_5 kg ha^{-1} in Lawar Khas location at the surface (0-15 cm), whereas, at subsurface (15-30 cm) maximum 21.98 P_2O_5 kg ha^{-1} was found in Sultannagar location and minimum 12.21 P_2O_5 kg ha^{-1} in Lawar Khas location. The range is quite large which might be due to variation of soil properties *viz*., pH, calcareousness, organic matter content, texture and various soil management and agronomic practices. Based on the limit suggested by Muhr *et al.* (1968) 42% of samples were rated low (<25 P_2O_5 kg ha^{-1}) and 58% of samples were medium (16-35 P_2O_5 kg ha^{-1}). However, the highest available phosphorus was observed in the surface horizons and decreased regularly with depth. Higher phosphorus in the surface horizons might be due to the confinement of crop cultivation to this layer and supplement of the depleted phosphorus through external sources *i.e.* fertilizers (Rajeswar *et al*., 2009). Similar results were reported by Thangaswamy *et al*. (2005).

Available potassium (K_2O) surface (0-15 cm) and subsurface (15-30 cm) ranged between 170.66 to 248.56 and 103.20 to 185.12 kg ha^{-1} K_2O (Table 3). The maximum available potassium 248.56 kg ha^{-1} K_2O was found at Sultannagar and a minimum of 170.66 kg ha^{-1} K_2O in Lawar Khas location at the surface (0-15 cm). Similarly, maximum available potassium 185.12 K_2O kg ha^{-1} was found in Sultannagar and minimum 103.20 K_2O kg ha^{-1} Rahawati locations at subsurface (15-30 cm). Due to unawareness about potassium application and more removal from soils by crops available K is lower. In grasslands, wastes land and forest soils, probably loss K removal by plants, maintained a comparatively higher K in soils (Choudhary Ram, 2005). According to Muhr *et al.* (1963), no sample was found in the low range (<125 K_2O kg ha^{-1}) however were the medium range (125-300 kg $ha^{-1}K_2O$ the surface (0-15 cm) and Subsurface (15-30 cm). A significant positive correlation was observed between organic carbon and available potassium content. This might be due to the creation of a favorable soil environment with the presence of high organic matter. Similar results were also reported by Paliwal (1996); Chouhan (2001).

Relationship of pH and OC with soil properties

Relationships of pH and Organic carbon with some soil properties like Available N, P and K were established by the determination of correlation coefficient values (Table 1).

OC significantly and positively correlated with the above discussed soil properties (r= 0.952, 0.658, 0.960 and subsurface, r= 0.983, 0.973 and 0.795 respectively).

The analysis indicates that pH was negatively correlated with Available N, P and K in surface (0-15 cm) and subsurface (15-30 cm).

CONCLUSION

In-depth wise availability was affected by Rice - Pea-Sugarcane cropping system and the properties of soil indicate that the soils of the study area were neutral to strongly alkaline in reaction and non-saline in nature. Nutrient status in surface and subsurface depth of soil indicates that soils are low in available N and medium in available P and available K in surface and subsurface soil layer of the profiles. Relationships of pH and Organic carbon with some soil properties like Available N, P and K were established by determination of correlation coefficient. The analysis indicates that pH was negatively correlated with Available N, P, K similar results were observed by Tisdale *et al.* (1997), Similar results were also noticed by Singh (1988) in the soils of Udaipur. OC significantly and positively correlated with the above-discussed soil properties. So the cropping system is useful for soil health sustainability.

Conflict of interest

All authors declare that they have no conflict of interest.

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