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Study of soil chemical properties under major cropping systems of SPSR Nellore district, Andhra Pradesh, India

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ABSTRACT

A study was carried out during 2021-22 in SPSR Nellore district of Andhra Pradesh, India to know the impact of major cropping systems on soil chemical properties. A total of 240 soil samples (120 surfaces and 120 sub-surface) under six major cropping systems *viz.*, paddy-paddy, fallow-paddy, groundnut-paddy, paddy-cotton, paddy-greengram and paddy-blackgram were collected and analysed for chemical properties. The results revealed that the highest available N, P and K was noticed with paddy-blackgram cropping system in surface and sub-surface soils (259 and 230 kg ha^{-1} of available N, 46.87 and 42.07 kg ha^{-1} of available P, 448 and 429 kg ha^{-1} of available K, respectively). The lowest available nitrogen was observed in paddy-cotton (126 kg ha^{-1}) cropping system in surface soils and paddy-paddy (109 kg ha^{-1}) cropping system in sub-surface soils, available phosphorus reported lowest in soils of paddy-cotton cropping system (24.51 and 19.98 kg ha^{-1}) in both surface and sub-surface soils, respectively and available potassium recorded lower in paddy-paddy cropping system (271 and 245 kg ha^{-1}) in both surface and sub-surface soils, respectively.

Key words*: Cropping systems, Soil chemical properties, Surface and sub-surface soils, SPSR Nellore district, Andhra Pradesh*

Introduction

Crop rotations widely known to have a major influence on soil chemical properties such as increase in available N, P and K (Wilson *et al*., 1982). Generally, crop rotations increase soil C more than a monoculture or fallow. Aref and Wander (1998) reported that organic matter content was least in monoculture and largest in a crop rotation this increase in organic carbon content increases the soil nutrient status especially soil nitrogen. Soil N can be high in crop rotations, especially when legumes are included and leaching is reduced. The contribution of a legume as a source of N could be as much as 120 kg N/ha (Ebelhar *et al*., 1984 and Hargrove, 1986). Leaching of NO_3-N is usually lower in crop rotations than in continuous cropping (Anderson *et al*., 1997; Arshad *et al*., 1998). Legumes can also have a positive influence on available P by altering the rhizosphere. The long-term inclusion of pulses in crop rotations improved the soil fertility, subsequently increased the crop nutrient acquisition and crop productivity (Venkatesh *et al*., 2012). The organic matter quality and quantity can have beneficial effects on soil quality because organic matter is related to aggregation, soil structure, and water infiltration and availability

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of nutrients to crop. Keeping the above facts in view the present investigation was done to understand the influence of cropping systems on soil chemical properties.

Materials and Methods

The present study was carried out in SPSR Nellore district of Andhra Pradesh, India which falls under southern Agro-climatic zone and geographically, located between 14° 42 12.93 and 14^0 572 56.822 North latitudes and 79^0 302 29.622 and 80^0 42 24.722 East longitudes. Two hundred and forty soil samples (120 surfaces at 0-15 cm and 120 sub-surface at 15-30 cm) were collected from six major cropping systems *viz.,* paddy-paddy, fallow-paddy, groundnut-paddy, paddy-cotton, paddy-greengram and paddy-blackgram of SPSR Nellore district by following random sampling technique during the year 2022. The exact sample location was recorded by using hand held GPS. The collected soil samples were analysed for chemical properties as per the procedure.

All the samples were analyzed for major nutrients available N was determined by alkaline permanganate method (Subbiah and Asija, 1956). The available P was extracted with the 0.5 *M* $NaHCO_3$ extractant and determined by using ascorbic acid as reducing agent Olsen *et al.* (1954) and the available K in the soils was extracted by employing Neutral normal ammonium acetate and determined by aspirating the extract into the flame photometer.

Soil samples were rated as low, medium and high categories as per the limits suggested by Ahmed *et al*. (2007) (Table 1) for available N, P_2O_5 and K_2O.

Results and Discussion

The data pertaining to chemical properties (available nitrogen, phosphorus and potassium) were presented in Table 2.

Available nitrogen

From the Table 1 it was indicated that the soils in paddy-blackgram cropping system reported higher available nitrogen (259 and 230 kg ha^{-1}, respectively) in both surface and sub-surface soils. While the lowest was observed in paddy-cotton (126 kg ha^{-1}) cropping system in surface soils and paddy-paddy (109 kg ha^{-1}) cropping system in sub-surface soils. The available nitrogen of surface soils in paddy-paddy, fallow-paddy, groundnut-paddy, paddy-cotton, paddy-greengram and paddy-blackgram cropping systems was ranged from 113-150, 116-170, 142-194, 110-140, 212-282 and 223-298 kg ha^{-1}, respectively (Fig. 1). The CV was 31.39 and 33.36 per cent for available nitrogen in surface and sub-surface soils of different cropping systems. The available nitrogen of soils under paddy-blackgram cropping system was higher than that of other cropping systems. Legumes have the ability to fix and store more atmospheric N through their symbiotic association with rhizobium bacteria resulted more available nitrogen

Table 1. Rating chart for available N, P and K

S. No.	Nutrient	Low	Medium	High
1.	Available N (kg ha^{-1})	< 280	280 – 560	> 560
2.	Available P_2O_5 (kg ha^{-1})	< 25	25 – 59	> 59
3.	Available K_2O (kg ha^{-1})	< 145	145 – 340	> 340

Table 2. Available N, P and K under major cropping systems of SPSR Nellore district, Andhra Pradesh

Cropping system	Available nitrogen (Kg ha^{-1})				Available phosphorus (Kg ha^{-1})				Available potassium (Kg ha^{-1})			
	0-15 cm		15- 30 cm		0-15 cm		15- 30 cm		0-15 cm		15- 30 cm	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Paddy-paddy	113-150	131	81-137	109	19.2-29.9	25.60	17.7-27.3	22.81	177-560	271	156-539	245
Fallow-paddy	116-170	142	101-152	124	23.6-35.6	29.51	20.1-33.5	26.03	243-400	335	224-379	310
Groundnut-paddy	142-194	169	120-182	146	29.7-45.3	37.06	21.0-42.0	31.91	224-388	310	209-354	292
Paddy-cotton	110-140	126	85-135	111	20.4-29.6	24.51	11.6-25.4	19.98	252-339	284	229-325	263
Paddy-greengram	212-282	242	176-245	213	36.3-53.1	42.87	29.4-47.7	37.45	235-510	377	218-489	361
Paddy-blackgram	223-298	259	169-281	230	29.7-58.7	47.03	26.1-54.7	42.07	280-676	448	267-645	429
CV (%)		31.39		33.36		28.98		32.04		26.20		28.38

in soils of paddy-blackgram cropping system (Kumar *et al*., 2020 and Kavitha *et al*., 2018). Low available nitrogen in some of soils might be due to most of the farmers applied complex fertilizers which may not meet the requirement of crops in adequate quantity. Hence suggested farmers fertilizers should be applied based on recommendations to particular crop Vajantha *et al*. (2010) and Leelavathy *et al*. (2020).

Available phosphorus

The data presented in Table 1 revealed that the available phosphorus was higher in paddy-blackgram cropping system (46.87 and 42.07 kg ha^{-1}) and the lowest was observed in the soils of paddy-cotton cropping system (24.51 and 19.98 kg ha^{-1}) in both surface and sub-surface soils, respectively. The range of available phosphorus in surface soils varied from 19.2-29.9, 23.6-35.6, 29.7-45.3, 20.4-29.6, 36.3-53.1 and 29.7-58.7 kg ha^{-1} in paddy-paddy, fallow-paddy, groundnut-paddy, paddy-cotton, paddy-greengram and paddy-blackgram cropping systems (Fig 2) and CV was 28.98 and 32.04 per cent for available phosphorus in surface and sub-surface soils of different cropping systems The available phosphorus of soils under paddy-blackgram cropping system was higher than that of other cropping systems. Crop rotations with legumes, can increase root colonization by mycorrhizae. Mycorrhizal associations have the greatest impact on increasing P availability in soils by colonizing root. This may be also due to higher available N in paddy-blackgram cropping system with BNF causes positive interaction between available N and P. These results are in line with the findings of Newton *et al*. (2011), Vajantha *et al*. (2017), Vajantha *et al*. (2015), Leelavathy *et al*. (2021) and Kavitha *et al*. (2018). The low available p in paddy-paddy and paddy-cotton cropping systems may be ascribed to more P uptake by these crops and inadequate quantity of P fertilizers applied by farmers.

Available potassium

Available potassium was found to be high in paddy-blackgram cropping system (448 and 429 kg ha^{-1}) whereas the lowest was recorded in paddy-paddy cropping system (271 and 245 kg ha^{-1}) in both surface and sub-surface soils, respectively (Table 1).

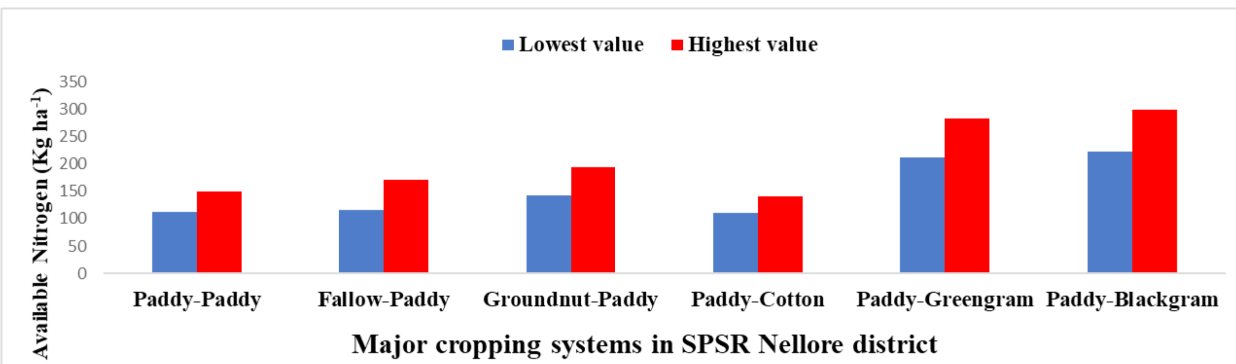

Fig. 1. Range of available nitrogen under major cropping systems of SPSR Nellore district, Andhra Pradesh

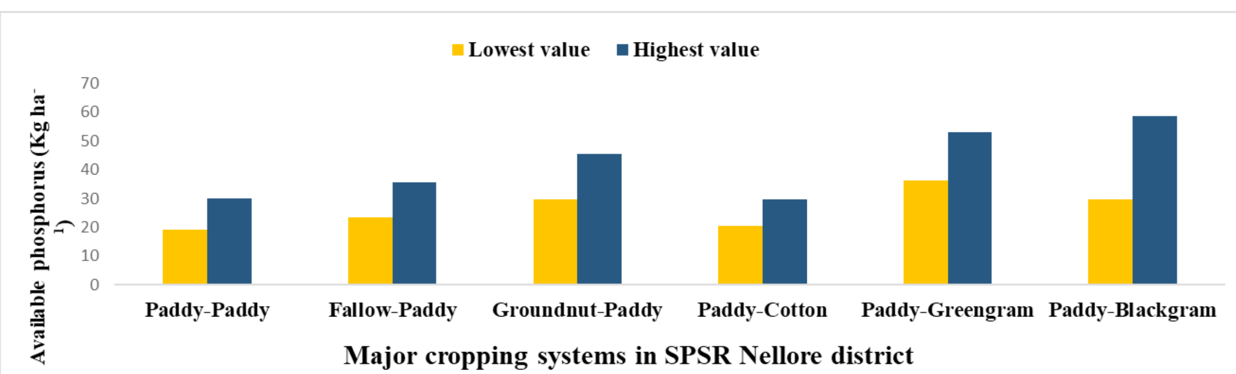

Fig. 2. Range of available phosphorus under major cropping systems of SPSR Nellore district, Andhra Pradesh

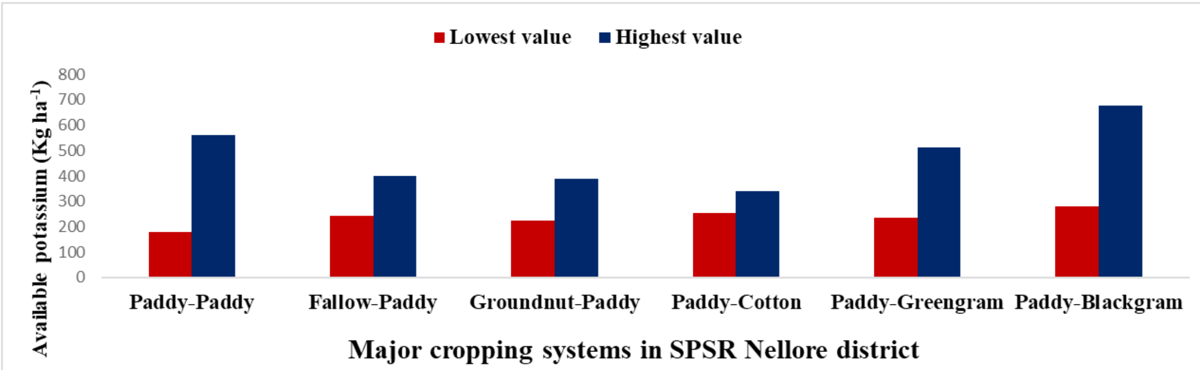

Fig. 3. Range of available potassium under major cropping systems of SPSR Nellore district, Andhra Pradesh

The available potassium in surface soils of paddy-paddy, fallow-paddy, groundnut-paddy, paddy-cotton, paddy-greengram and paddy-blackgram cropping systems ranged from 177-560, 243-400, 224-388, 252-339, 235-510 and 280-676 kg ha^{-1}, respectively (Fig. 3). The CV was 26.20 and 28.38 per cent for available potassium in surface and sub-surface soils of different cropping systems. The highest available potassium was observed in soils of paddy-blackgram cropping system in both surface and sub-surface soils. This might be attributed to addition of large amount of K through crop residues. The results are in agreement with the findings of Malecka *et al*. (2012), Jat *et al*. (2018), Vajantha *et al*. (2014), Kavitha *et al*. (2019) and Suguna *et al*. (2023).

Conclusion

From this study, it was concluded that the different paddy based cropping systems affect the chemical properties of soils of SPSR Nellore district of Andhra Pradesh. Among, the cropping systems paddy-blackgram followed by paddy-greengram cropping system sustained better chemical properties of soils than that of soils under paddy-paddy, fallow-paddy, groundnut-paddy and paddy-cotton cropping systems. Therefore, the present study recommended that to sustain soil health to become productive for next generation rice-legume cropping systems could be more effective.

Conflict of interest

None

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