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Exploring the intriguing physico-chemical traits of maize (*Zea mays* L) cultivated in diverse soils across Telangana, India

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ABSTRACT

The main occupation of Telangana, India, is agriculture. Achieving food security requires intelligent management to increase land use productivity and production per unit area because of the expanding population and decreasing amount of agricultural land per capita. In this sense, assessing the productivity and fertility of the soil is a necessary step toward sustainable agricultural development. This study assesses maize cultivation across red, black, and alluvial soils in Telangana's districts, using a random sampling approach to analyze soil fertility characteristics. A total of 119 soil samples were collected from a depth of 0-15 cm beneath maize crops grown between 2018 and 2020. These samples exhibited a pH ranging from slightly acidic to alkaline and contained low levels of organic matter. The available nitrogen (N), phosphorus (P), and potassium (K) in the soil varied; in red soil, they were 63-326 kg ha^{-1}, 20-150 kg ha^{-1}, and 152-736 kg ha^{-1}; in black soil, they were 75-364 kg ha^{-1}, 40-127 kg ha^{-1}, and 113-476 kg ha^{-1}; and in alluvial soil, they were 50-320 kg ha^{-1}, 24-132 kg ha^{-1}, and 108-429 kg ha-1, appropriately. The available nutrient ranges in all soils were 50-364 kg ha^{-1}, 20-150 kg ha^{-1}, and 108-736 kg ha^{-1}, respectively.

Keywords: *soil fertility, physico-chemical properties; macronutrient status; maize; red soil; black soil; alluvial soil; agro-climatic zones.*

Introduction

Humans longstanding reliance on agriculture for fundamental needs such as food, clothing, and shelter since ancient times, agriculture has played a crucial role in human survival. Cereals like wheat, rice, and maize [9] constitute our staple foods, providing essential calories. Maize (*Zea mays* L), known globally as the 'Queen of Cereals' due to its exceptional genetic yield potential, thrives under diverse agro-climatic conditions [18][23]. In India, maize ranks as the third largest food crop by cultivated area, with significant production zones including Bihar, Maharashtra, Tamil Nadu, Telangana, West Bengal, and Gujarat (http://agricoop.nic.in).

Balancing nutrient application to prevent both excesses and deficiencies is crucial for ecological sustainability and maintaining crop productivity [11]. The judicious use of nitrogen, phosphorus, and potassium (NPK) fertilizers has been pivotal in achieving the Green Revolution and increasing agricultural yields worldwide [4][5]. Modern agricultural practices emphasize creative fertilization strategies to sustain soil productivity [7].

As global food demand escalates alongside population growth, assessing and enhancing soil fertility becomes imperative to meet agricultural challenges effectively [24]. Optimizing agricultural practices and ensuring sustainable land management hinge on understanding soil fertility. This involves a comprehensive evaluation of physico-chemical and chemical properties influencing nutrient availability and overall soil health.

Diagnostic techniques are essential for assessing soil nutrient status and ensuring optimal nutrient availability for crops [1]. Intensive agricultural practices, marked by unbalanced chemical fertilizer use and excessive tillage without organic manure, contribute to soil degradation and reduced crop health [3]. Soil testing provides precise insights into plant-available nutrients, critical for sustainable agricultural practices [29].

This study focuses on analyzing the physico-chemical and chemical properties of maize-cultivated soils across different zones in Telangana, India. It aims to provide valuable insights for fostering sustainable agricultural practices in these regions.

Material & Methods

Description of study area

Based on five years of maize cultivation data from the Department of Economics and Statistics, Government of Telangana, India, the top 10 maize-growing *mandals* in each district were selected. Telangana's districts are divided into three zones—Northern Telangana Zone (NTZ), Central Telangana Zone (CTZ), and Southern Telangana Zone (STZ), each comprising 10 districts. *Mandal* with significant maize acreage was identified based on predominant red, black, and alluvial soils, reflecting the soil distribution ratio of 56:21:9 in Telangana.

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These selected *mandals* were categorized according to their predominant soil types (red, black, and alluvial) within each zone, as defined by the NBSSLUP soil map from Nagpur. A total of 119 composite soil samples representing different maize fields (spanning 47 distinct soil series) were collected between 2018-19 and 2019-20. GPS coordinates were recorded for each sampling site using Garmin eTrex90. Among the samples collected, 38 were from NTZ, 45 from CTZ, and 36 from STZ, with their specific locations depicted in Figure 1.

Soil sampling

Soil sampling was conducted in 2018-19 and 2019-20 before planting. Samples were taken at 0-15 cm depth using a quadrat sampling method. A total of 58 composite red soil samples, 30 composite black soil samples, and 31 composite alluvial soil samples were collected from representative locations in Telangana, India where maize was cultivated. These samples were air-dried, ground, sieved (2 mm), and stored in labeled bags for laboratory analysis of their physico-chemical properties.

Soil characterization

This study assessed the soil fertility properties including physico-chemical properties (pH, EC, and organic carbon) and available macronutrients (available N, P, K). Soil pH was measured using air-dried soil mixed with distilled water at a ratio of 1:2.5, employing a pH meter with a glass electrode [14]. Electrical conductivity was determined in a 1:2.5 soil-water suspension using a digital conductivity meter [14]. Organic carbon content in dry soil samples was analyzed using the Walkley–Black method [35]. Available nitrogen was estimated via the alkaline potassium permanganate method [32]. Available phosphorus was extracted using Olsen's extractant method [20] and quantified using ascorbic acid and a colorimeter (Model ECIL GS 5701 SS) at 660 nm wavelength [36]. Available potassium was extracted using the neutral normal ammonium acetate method [14] and determined by flame photometry (Model Elico CL 361).

Statistics

To evaluate the fertility of various soil types comprehensively, descriptive statistics were employed to analyze six key soil properties. This approach, outlined by Gomez and Gomez [10], enabled the calculation of minimum, maximum, and mean values for each property across the different soil types, within Telangana's diverse agro-climatic zones.

Results

The fertility of soils supporting maize cultivation, including red, black, and alluvial types across various agro-climatic zones in Telangana, India, was assessed, with findings detailed separately under each specific category.

Red soils

Fifty-eight soil samples were collected from cultivated fields of fifty-four maize crop area predominant *mandal*s of the state. Care was taken to collect samples from the red soil mapped unit area of the NBSSLUP map and also through field observations on the ground. The analytical data of these soil samples are given in Table 2.

pH: The red soils supporting maize in these *mandals* recorded pH in the range of 6.48 to 7.92 within the sampled areas. These red soils registered pH in the range of 6.61 to 7.76 in NTZ, 6.52 to 7.92 in CTZ, and 6.48 to 7.89 in STZ. The lowest pH in maize field among red soils in the state was recorded at 6.52 in the Parvathagiri *mandal* of Warangal rural of CTZ. The highest 7.92 pH of maize soil was recorded in Velair *mandal*, Warangal urban of CTZ.

EC: The EC of samples ranged from 0.078 to 0.538, 0.075 to 0.763, and 0.120 to 0.664 with mean of 0.231, 0.323, and 0.332 dSm^{-1} in NTZ, CTZ, and STZ, respectively in maize supporting red soils. The EC of maize growing red soils of the state ranged from 0.07 to 0.77 with a mean of 0.30 dSm^{-1}. The data indicated that the red soils supporting maize were non saline.

OC: The data presented in Table 2 indicated that the mean OC of red soils supporting maize crop in the state was 0.5 per cent with a range of 0.13 to 1.54%. The OC content ranged from 0.20 to 0.74 in NTZ, 0.13 to 0.79 in CTZ, and 0.35 to 1.54% in STZ. Most of the soils *i.e* to an extent of 83 per cent were found to be low in OC status in NTZ and CTZ, whereas, it was low only 11% in STZ among maize-supporting red soils of the state. Overall, OC in maize-supporting red soils of the state indicated that 62, 22, and 16% of soil samples were low, medium, and high in status, respectively.

Available N: The available nitrogen status of red soils on which maize is grown in the state was found to range from 63 to 326 with a mean of 183 kg ha^{-1}. Hundred per cent soil samples were low in their NTZ and CTZ, whereas 78% of samples were low in STZ. Across the State, it ranged from 100 to 264, 63 to 263, and 151 to 326 with a mean of 165, 152, and 242 kg ha^{-1} in NTZ, CTZ, and STZ, respectively. In maize-growing red soils of the state, an extent of 93 and 7 per cent soil samples were found to be low and medium status in available nitrogen status, respectively.

Available P_2O_5: The available phosphorus status in maize-supporting red soils (n=58) of the state ranged from 20 to 150 with a mean of 92 kg P_2O_5 ha^{-1}. The available phosphorus ranged from 42 to 136, 64 to 150, and 20 to 99 with mean of 97, 101, and 75 kg P_2O_5 ha^{-1} in NTZ, CTZ and STZ, respectively. In predominantly maize-supporting red soils of the state, the available phosphorus status indicated that 43, 7, and 52 per cent of soil samples were low, medium, and high in their status, respectively.

Available K_2O: The available potassium status of red soils on which maize is grown predominantly in the state was found to range from 152 to 736 with a mean of 361 kg K_2O ha^{-1}. Most of these soils were high in available potassium across the state and it ranged from 232 to 606, 164 to 594, and 152 to 736 with a mean of 347, 367, and 366 kg K_2O ha^{-1} in NTZ, CTZ, and STZ, respectively. In maize-growing red soils of the state, an extent of 46.55 and 53.45 per cent of soil samples were found to be medium and high in status, respectively whereas nil samples were noticed under the low category in available potassium status.

Black soils: From maize cultivated fields, thirty soil samples were collected from twenty-five black soil predominant *mandal*s in three agro-climatic zones of the state. Care was taken to collect samples from the black soil mapped unit area of the NBSSLUP map and also through field observations on the ground. The analytical data of these soil samples are given in Table 3.

pH: The pH of maize-supporting black soils in the state ranged from 7.03 to 8.34. The pH was 7.03 to 8.10, 7.15 to 8.06, and 7.10 to 8.34 in NTZ, CTZ, and STZ, respectively in maize-supporting black soils. The data indicated that the black soils supporting maize were neutral to slightly alkaline.

EC: The EC in maize-supporting black soils ranged from 0.108 to 0.217, 0.045 to 0.23, and 0.098 to 0.247 with a mean of 0.170, 0.147, and 0.183 dSm^{-1} in NTZ, CTZ, and STZ, respectively. The EC of maize supporting black soils in the state ranged from 0.045 to 0.247 with a mean of 0.15 dSm^{-1}. The black soils supporting maize in the state were non saline.

OC: Data presented in Table 2 indicated that about 63 per cent soil samples were low, 24% soil samples were medium and 13% soil samples were high in OC status in maize-supporting black soils of the state. The OC in maize supporting black soils of the state, thus, ranged from 0.12 to 1.15 with a mean of 0.51 per cent. The OC ranged from 0.20 to 1.15, 0.12 to 0.44, and 0.31 to 0.94 with a mean of 0.59, 0.30, and 0.57 per cent in NTZ, CTZ and STZ, respectively. The mean OC was highest (0.59%) in NTZ soil samples followed by STZ (0.57%) and CTZ (0.30%).

Available N: The available nitrogen in maize-grown black soils of the state was found to be low in 87 per cent of samples followed by medium in 13 % of samples. The high status of nitrogen in maize-grown black soils of the state was found to be nil. The available nitrogen in black soils supporting maize in the state ranged from 75 to 364 with a mean of 175 kg ha^{-1}. The mean available nitrogen status in maize-supporting black soils was highest in STZ (283 kg ha^{-1}), followed by CTZ (180 kg ha^{-1}) and NTZ (129 kg ha^{-1}).

Available P_2O_5: The available phosphorus status in maize supporting black soils of the state ranged from 40 to 127 with a mean of 80 kg P_2O_5 ha^{-1}. The available phosphorus ranged from 48 to 127, 40 to 113, and 58 to 81 with a mean of 90, 77, and 70 kg P_2O_5 ha^{-1} in NTZ, CTZ, and STZ, respectively. In maize supporting black soils of the state, the available phosphorus status indicated that 80% of soil samples were high 20% of soil samples were medium and none of the samples were found in low status.

Available K_2O: The mean available K_2O of black soils supporting maize crop in the state was 325 kg ha^{-1} with a range of 113 to 476 kg K_2O ha^{-1}. The potassium availability in soils ranged from 182 to 476 in NTZ, 113 to 416 in CTZ, and 271 to 410 kg K_2O ha^{-1} in STZ. Most of the soils *i.e.* to an extent of 65 per cent were found to be high in available potassium status among maize-supporting black soils of the state.

Alluvial soils

From maize-cultivated alluvial soil predominant *mandals*, thirty-one soil samples were collected from fourteen *mandal*s in three agro-climatic zones of the state. Based on NBSSLUP soil mapped unit areas and also through field observations these alluvial soil samples (n=31) were collected in Telangana State. The analytical data of these soil samples are given in Table 4.

pH: The pH in alluvial soils supporting maize was found to range from 6.48 to 8.14. In maize supporting alluvial soils, it ranged from 6.48 to 7.94, 6.48 to 8.14, and 6.87 to 7.50 in NTZ, CTZ, and STZ, respectively.

EC: The electrical conductivity data of alluvial soils supporting maize ranged from 0.117 to 0.204 in NTZ, 0.040 to 1.667 in CTZ, and 0.146 to 0.310 dSm^{-1} in STZ. The overall mean of EC in alluvial soils supporting maize in the state was found to be 0.22 dSm^{-1}.

OC: Data presented in Table 3 indicated that the mean OC of alluvial soils supporting maize crops in the state was in the range of 0.12 to 1.34 with a mean of 0.36 per cent. The OC ranged from 0.16 to 1.34 per cent in NTZ, 0.19 to 0.59% in CTZ, and 0.12 to 0.49% in STZ. Most of the soils were found to be low in OC among maize-supporting alluvial soils of the state. About 93.5 per cent of soil samples were found to be low in OC status in the state where maize supporting alluvial predominant *mandals*.

Available N: The mean available N of alluvial soils supporting maize crop in the state was 157 kg ha^{-1} with a range of 50 to 320 kg ha^{-1}. The nitrogen availability in soils ranged from 50 to 183 in NTZ, 72 to 205 in CTZ, and 122 to 320 kg ha^{-1} in STZ. Most of the analyzed soils were found to be low in the available nitrogen category among maize-supporting alluvial soils of the state.

Available P_2O_5: The available phosphorus in maize-grown alluvial soils of the state was found to be high in 80.65 per cent of samples and 16.13% of samples were in medium followed by low in the rest of 3.23% of samples analyzed. Thus, the available phosphorus in alluvial soils supporting maize in the state ranged from 24 to 132 kg P_2O_5 ha^{-1} with a mean of 79 kg P_2O_5 ha^{-1}.

Available K_2O: The mean available K_2O of alluvial soils supporting maize crop in the state was 304 kg K_2O ha^{-1} with a range of 108 to 429 kg K_2O ha^{-1}. The potassium availability ranged from 108 to 429 in NTZ, 140 to 413, and 165 to 412 kg K_2O ha^{-1} in CTZ. Most of the soils *i.e.* to an extent of 55 per cent were found to be medium and 39% of samples in high and the rest of the 6% samples in low available potassium among maize-supporting alluvial soils of the state.

Soil fertility status of maize supporting all soils of Telangana, India

Data presented for soil fertility status after combining all types of soils total of 119 revealed the following.

The pH ranged from 6.48 to 8.34, EC ranged from 0.04 to 1.67 with a mean of 0.24 dSm^{-1} and organic carbon ranged from 0.12 to 1.54 with a mean of 0.46%. The maize-supporting soils in the state recorded 71.43, 16.81 and 11.76% of low, medium, and high-status categories of OC, respectively (Table 5).

Available N of maize-supporting soils ranged from 50 to 364, P_2O_5 from 20 to 150, and available K_2O from 108 to 736 with mean of 178, 86, and 338 kg ha^{1}, respectively (Table 5). The available N, P, and K status in the state indicated that (fig. 2) 91.6 per cent of soil samples were low in available nitrogen status, 85.71% were high in available P, and 51.26% of samples were high K status in maize supporting soils of the state.

Discussion

During surveys, sampling is typically done on a grid basis. However, the following methodology was used in this study to reflect maize-cultivated soils, cover all three primary types of soils, and cover all state districts.

Based on five years of prior data, the top 10 *mandal's* with the highest maize acreage were selected from Telangana's 32 districts.

A total of 91 *mandal's* were chosen across the state, representing a distribution of 29 in NTZ, 33 in CTZ, and 29 in STZ, based on the predominant occurrence of red, black, and alluvial soils. Soil samples were collected using NBSSLUP soil maps at the *mandal* level and Department of Agriculture data to cover the entire state, focusing on maize-supporting areas, which are key staple crop regions in Telangana, India.

A total of 119 soil samples were collected from maize-cultivated soils in *mandal's* dominated by red, black, and alluvial soils across Telangana's districts during the 2018-19 and 2019-20 surveys. These samples were analyzed specifically for fertility aspects and key elements such as nitrogen (N), phosphorus (P), and potassium (K). The findings from these analyses are detailed below.

Physico-chemical Properties

The pH levels of 119 soil samples from maize-supporting soils ranged from 6.48 to 8.34 (Table 5). Specifically, pH ranged from 6.48 to 7.92 in red soils, 7.03 to 8.34 in black soils, and 6.48 to 8.14 in alluvial soils. These findings align closely with previous studies [34], who extensively documented soil fertility characteristics in Telangana, India. Similar pH ranges have also been reported in other regions, such as Kanchipuram district, Tamil Nadu [21], red soils of Karnataka [16], and black soils supporting paddy [22].

The electrical conductivity (EC) of 119 soil samples supporting maize cultivation ranged from 0.01 to 1.85 dSm^{-1} (Table 5), indicating normal levels without salinity issues. There was minimal variation in EC across different zones, reflecting consistent conditions in both red and black soil zones. Similar EC ranges have been documented not only in Telangana but also in various agricultural fields by researchers in different regions [28][2].

In the surveyed 119 samples across Telangana, organic carbon content ranged from 0.12% to 1.54%, with a mean of 0.46%. Specifically, the mean organic carbon content was lower in NTZ (0.45%) and CTZ (0.35%), and higher in STZ (0.56%). Among soil types, black soils (0.5%) and red soils (0.5%) showed the highest mean organic carbon content, followed by alluvial soils (0.36%). Generally, organic carbon levels are reported to be low to medium not only in Telangana but also in various states across India, influenced by factors such as reduced application of organic manures, high temperatures, and limited residue recycling [30][27][13].

Macronutrients

The macronutrient availability of soil samples under survey was examined. It was discovered that the amount of nitrogen accessible was low, ranging from 50 to 364 kg ha^{-1} with a mean of 178 kg ha^{-1} in 119 samples. The low category (less than 280 kg ha^{-1}) was further split into two categories: extremely low (less than 140 kg ha^{-1}) and low (141 to 280 kg ha^{-1}) to obtain a better knowledge of nitrogen availability. This led to the discovery that 46 out of 119 samples, or 39%, had extremely low amounts of accessible nitrogen. Such a sub-classification of the very low category of nitrogen is meaningful to prioritize green manuring, organic manure addition, etc., and is being reported and used within the currently approved low category of < 280 kg ha^{-1}.

The mean accessible nitrogen content of the soils was highest in the STZ zone (249 kg ha^{-1}), followed by the CTZ and NTZ zones (151 kg ha^{-1} and 142 kg ha^{-1}, respectively). Since the reasons for low accessible nitrogen status have already been listed for the organic carbon content, this is a common observation in many soils and many parts of the state and nation.

The inadequate availability of nitrogen in the soil has long been documented as a widespread occurrence in the nation [15][31].

The surveyed samples predominantly showed a high status of available phosphorus, with 86% of the 119 samples analyzed falling into the high category according to the classification [20], averaging 86 kg P_2O_5 ha^{-1}. Within this high category, 68% of soils were further categorized as having very high phosphorus availability, as delineated in soil maps of Telangana state [34]. Noted that crops like sunflower benefit from such soils with very high phosphorus levels [17].

The data in Tables 2-4 also shows that phosphorus availability varied among soil types, with 92% of soils in NTZ, 81% in CTZ, and 83% in STZ categorized as having high available phosphorus. Red soils exhibited the highest mean available phosphorus at 92% in the high category, followed by black and alluvial soils at 80% and 79%, respectively. Low phosphorus availability was minimal, observed in less than 2% of the surveyed samples.

Continuous use and indiscriminate application of high-analysis phosphorus fertilizers like DAP have led to phosphorus buildup in soils over time, influencing soil fertility maps across India. This phenomenon, reported previously [34], is corroborated by the current findings.

Analysis of potassium availability in the surveyed 119 soil samples across different districts of Telangana, India showed that 3% exhibited low availability, 46% medium, and 51% high availability. The highest potassium availability was observed in the STZ zone (59%), while the medium category predominated in the NTZ zone (51%) and the low category was most prevalent in the CTZ zone (10%). Among soil types, black soils had the highest proportion of samples in the high availability category (57%), followed by red soils (53%) and alluvial soils (38%).

The potassium availability in Indian soils is reported to be medium to high in many instances [26][9][34]. Potassium-rich minerals vary in different types of soils and hence the present variation in potassium availability of surveyed samples is expected [6][12].

Conclusion

The findings of the maize-cultivated soil survey unambiguously show that there is no salinity present in the soil samples, and they show normal soil response and electrical conductivity levels. Furthermore, the average level of organic carbon is low at 0.46%, 92% of the samples show low nitrogen levels. This is a significant majority. In contrast, the diverse soils of Telangana exhibit high (51%) to medium (45%) potassium levels, and widespread high phosphorus availability (86%), with an average value of 86 kg P_2O_5 ha^{-1}.

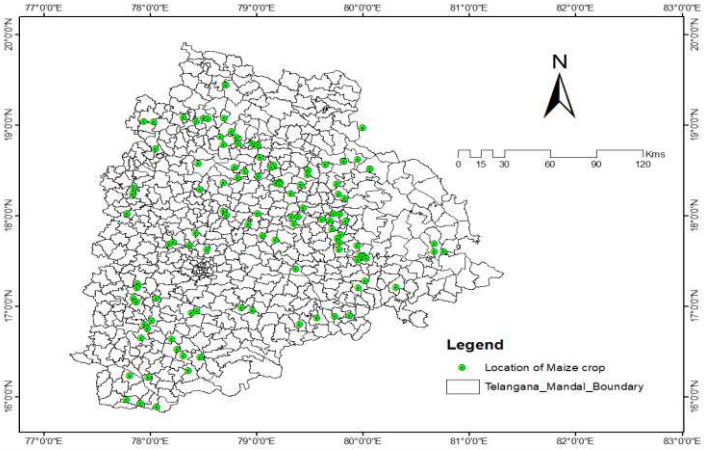

Figure 1: Soil sample location sites mapped in Telangana, India

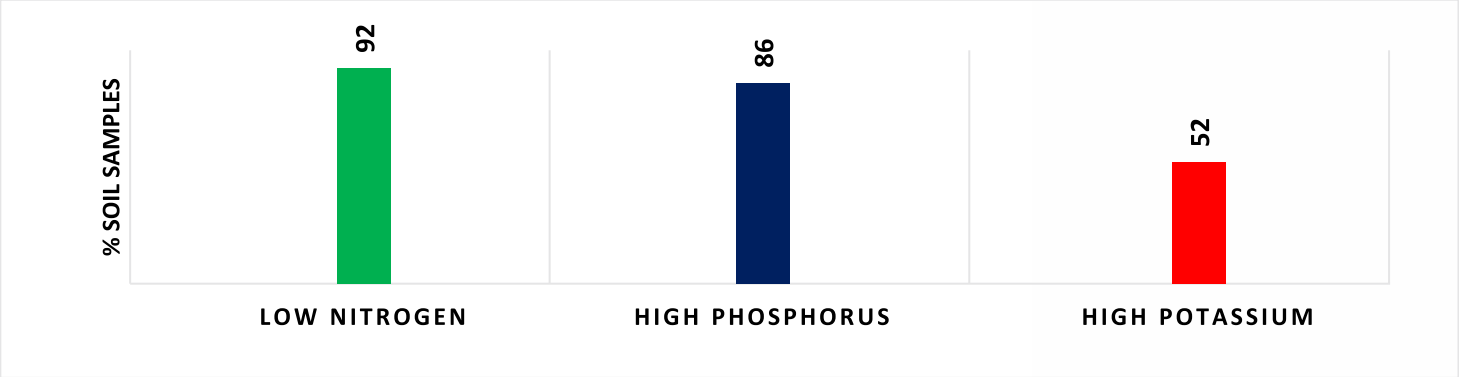

Fig. 2. Soil fertility status in maize grown soils of Telangana, India

Table 1. Number of soil samples collected from different agro-climatic zones of Telangana, India

Crop	Zone	No. of *mandal's*	No. of soils collected in *mandal's* with predominant soil types			Total
			Red	Black	Alluvial	
Maize	NTZ	29	16	12	10	38
	CTZ	33	24	10	11	45
	STZ	29	18	8	10	36
Total		91	58	30	31	119

Table 2. Soil characteristics of maize grown red soils in different agro-climatic zones of Telangana State

Zone		pH	EC	OC	Available Nutrients		
					N	P_2O_5	K_2O
			(dSm^{-1})	(%)	($kg\ ha^{-1}$)		
NTZ (16 no's)	Range	6.61-7.76	0.078-0.538	0.20-0.74	100-264	42-136	232-606
	Mean		0.231	0.37	165	97	347
	Low			13	16	0	0
	%			81.25	100.00	0.00	0.00
	Medium			3	0	1	11
	%			18.75	0.00	6.25	68.75
	High			0	0	15	5
	%			0.00	0.00	93.75	31.25
CTZ (24 no's)	Range	6.52-7.92	0.075-0.763	0.13-0.79	63-263	64-150	164-594
	Mean		0.323	0.37	152	101	367
	Low			21	24	0	0
	%			87.50	100.00	0.00	0.00
	Medium			2	0	0	11
	%			8.33	0.00	0.00	45.83
	High			1	0	24	13
	%			4.17	0.00	100.00	54.17
STZ (18 no's)	Range	6.48-7.89	0.120-0.664	0.35-1.54	151-326	20-99	152-736
	Mean		0.332	0.79	242	75	366
	Low			2	14	1	0
	%			11.11	77.78	5.56	0.00
	Medium			8	4	3	5
	%			44.44	22.22	16.67	27.78
	High			8	0	15	13
	%			44.44	0.00	83.33	72.22
Overall zone (58 no's)	Range	6.48-7.92	0.075-77	0.13-1.54	63-326	20-150	152-736
	Mean		0.30	0.5	183	92	361

Table 3. Soil characteristics of maize grown black soils in different agro-climatic zones of Telangana State

Zone		pH	EC	OC	Available Nutrients		
					N	P_2O_5	K_2O
			(dSm^{-1})	(%)	(kg ha^{-1})		
NTZ (12 no's)	Range	7.03 -8.10	0.108 -0.217	0.20 -1.15	92 - 176	48 - 127	182 - 476
	Mean		0.17	0.59	129	90	356.90
	Low			6	12	0	0
	%			50.00	100.00	0.00	0.00
	Medium			4	0	1	3
	%			33.33	0.00	8.33	25.00
	High			2	0	11	9
	%			16.67	0.00	91.67	75.00
CTZ (10 no's)	Range	7.15 -8.06	0.045 -0.23	0.12 - 0.44	75 - 276	40 - 113	113 - 416
	Mean		0.147	0.30	180	77	259.500
	Low			10	10	0	2
	%			100.00	100.00	0.00	20.00
	Medium			0	0	4	6
	%			0.00	0.00	40.00	60.00
	High			0	0	6	2
	%			0.00	0.00	60.00	20.00
STZ (8 no's)	Range	7.10 -8.34	0.098 -0.247	0.31 -0.94	213 - 364	58 - 81	271 - 410
	Mean		0.183	0.57	283	70	358.23
	Low			3	4	0	0
	%			37.50	50.00	0.00	0.00
	Medium			3	4	1	2
	%			37.50	50.00	12.50	25.00
	High			2	0	7	6
	%			25.00	0.00	87.50	75.00
Overall zone (30 no's)	Range	7.03-8.34	0.045-0.247	0.12-1.15	75-364	40-127	113-476
	Mean		0.15	0.50	175	80	325

Table 4. Soil characteristics of maize grown alluvial soils in different agro-climatic zones of Telangana State

Zone		pH	EC	OC	Available Nutrients		
					N	P_2O_5	K_2O
			(dSm^{-1})	(%)	(kg ha^{-1})		
NTZ (10 no's)	Range	6.48-7.94	0.117-0.204	0.16-1.34	50-183	57-132	108-429
	Mean		0.16	0.40	121	94.39	280.11
	Low			9	10	0	1
	%			90.00	100.00	0.00	10.00
	Medium			0	0	1	6
	%			0.00	0.00	10.00	60.00
	High			1	0	9	3
	%			10.00	0.00	90.00	30.00
CTZ (11 no's)	Range	6.48-8.14	0.040-1.667	0.19-0.59	72 - 205	52-100	140-413
	Mean		0.298	0.37	131	81.495	332.602
	Low			10	11	0	1
	%			90.91	100.00	0.00	9.09
	Medium			1	0	2	4
	%			9.09	0.00	18.18	36.36
	High			0	0	9	6
	%			0.00	0.00	81.82	54.55
STZ (10 no's)	Range	6.87-7.50	0.146 - 0.310	0.12 - 0.49	122 - 320	24 - 82	165 - 412
	Mean		0.18	0.32	221	60.69	297.95
	Low			10	8	1	0
	%			100.00	80.00	10.00	0.00
	Medium			0	2	2	7
	%			0.00	20.00	20.00	70.00
	High			0	0	7	3
	%			0.00	0.00	70.00	30.00
Overall zone (31 no's)	Range	6.48-8.14	0.40-1.67	0.12-1.34	50-320	24-132	108-429
	Mean		0.22	0.36	157	79	304

Table 5. Soil characteristics belonging to different agro-climatic zones of Telangana State (Pooled data)

SOIL		pH	EC	OC	Available Nutrients		
					N	P_2O_5	K_2O
			(dSm^{-1})	(%)	(kg ha^{-1})		
Maize all soil samples (119 no's)	Range	6.48-8.34	0.04-1.67	0.12-1.54	50-364	20-150	108-736
	Mean		0.24	0.46	178	86	337
	Low			**85**	**109**	**2**	**4**
	%			71.43	91.60	1.68	3.36
	Medium			**20**	**10**	**15**	**54**
	%			16.81	8.40	12.61	45.38
	High			**14**	**0**	**102**	**61**
	%			11.76	0.00	85.71	51.26

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