Assessment of soil variables under different sesame productivities of Northern Telangana Zone

ABSTRACT

A survey was carried out in major sesame growing areas of Northern Telangana Zone in high, medium and low productivity zones of districts namely Nizamabad, Jagtial, Nirmal and Kamareddy. 50 surface soil samples (0-15 cm) were collected from each zone and a total of 150 surface soil samples were analysed for various physical, physico-chemical and chemical properties and the results shown that the bulk density ranged from 1.10 to 1.56 Mg m^{-3}, from 1.20 to 1.60 Mg m^{-3} and from 1.20 to 1.63 Mg m^{-3} in high, medium and low productivity zones respectively. Water holding capacity ranged from 30.00 to 56.80%, from 20.80 to 56.50% and from 19.60 to 51.70% in high, medium and low productivity zones respectively. pH ranged from 7.11 to 7.82, from 6.45 to 8.51 and from 6.81 to 7.46 in high, medium and low productivity zones respectively. EC ranged from 0.32 to 0.46 d Sm^{-1}, from 0.32 to 0.56 d Sm^{-1} and from 0.12 to 0.56 d Sm^{-1} in high, medium and low productivity zones respectively. Organic carbon ranged from 0.48 to 1.08%, from 0.23 to 0.72% and from 0.21 to 0.64% in high, medium and low productivity zones respectively. Available nitrogen ranged from 176.20 to 279.70 kg ha^{-1}, from 116.50 to 261.50 kg ha^{-1} and from 76.40 to 139.80 kg ha^{-1} in high, medium and low productivity zones respectively. Available phosphorus ranged from 13.41 to 82.33 kg ha^{-1}, from 11.81 to 64.71 kg ha^{-1} and from 19.98 to 49.06 kg ha^{-1} in high, medium and low productivity zones respectively. Available potassium ranged from 213.00 to 562.00 kg ha^{-1}, from 126.25 to 585.00 kg ha^{-1} and from 182.50 to 562.50 kg ha^{-1} in high, medium and low productivity zones respectively.

Key words: sesame, survey, productivity, nitrogen, urease.

1. INTRODUCTION

Soil is an important natural resource of earth, because of which survival of almost all living organisms is possible on earth. For the soil to be more productive, fertility status is the major constraint. Hence, soil fertility status need to be assessed to know the quality of soil. Based on the soil quality, fertilizer application need to be improved.

The major oilseed crop sesame (*Sesamum indicum* L.) is indigenous to India. It is primarily restricted to tropical and subtropical locations and is valuable for its high-quality edible oil and seed, which are used directly in confectionary. Sesame is grown in areas with rainfall ranging from 625 to 1100 mm and temperatures above 27^{o}C (Amit *et al.*, 2020). Sesame is known as "Queen of oilseeds", because of its high oil and protein content (Vilakar *et al.,* 2021). Sesame maintains a prominent role in the world trade since its significance is widely acknowledged. Additionally, the rise in sesame oil consumption over the past ten years is evidence of the crop's significance on a global scale.

In India, 2021-22 sesame is being grown over an area of 16.27 lakh hectares with production of 7.89 lakh tonnes and productivity of 485 kg ha^{-1} (Indiastat,2022). The cultivated area under sesame in Telangana state was 57,485 acres and production of 1,48,310 Lakh tonnes with a productivity of 645 kg ha^{-1} (Agriculture Action plan 2021-22). The sesame production is concentrated in Northern Telangana Zone and the area under sesame cultivation is higher (50,000 acres) compared to other districts of Telangana State. Soil fertility status is decreasing day by day and thereby, productivity of crops is also decreasing. The main reason for low productivity of sesame is use of low yielding varieties, poor soil fertility and imbalanced nutrition (Ranganatha, 2013). In India, nutrient status of soil is decreasing continuously because of extensive agricultural practices (Satyanarayana *et al.,* 2021). Though soil fertility status of some districts like Karimnagar, Adilabad is already available for various crops, information on sesame crop is meagre. Hence, present study was carried out to give detailed and updated information about the fertility status in major sesame growing areas of Northern Telangana Zone.

2. MATERIAL AND METHODS

Study area and Soil sample collection

Major sesame growing areas of Northern Telangana Zone namely Nizamabad, Jagtial, Nirmal and Kamareddy were divided into high, medium and low productivity zones based on the past five years yield data collected from farmers. 50 samples from each productivity zone and total of 150 surface (0-15 cm) soil samples were collected.

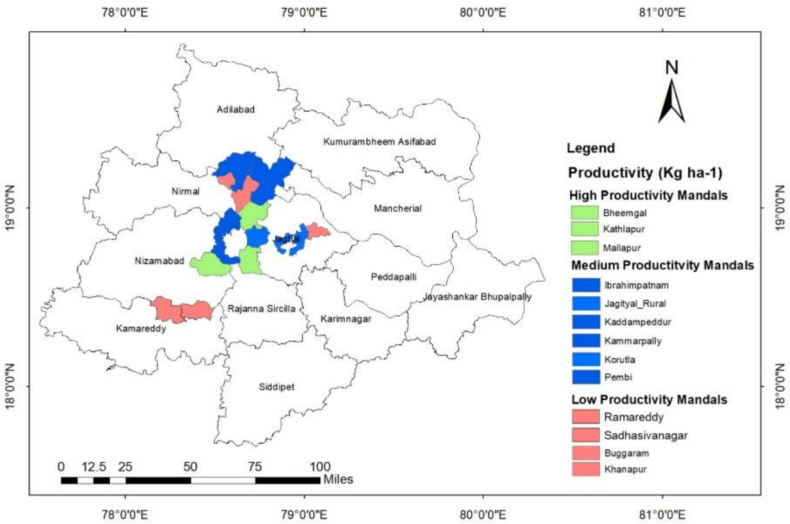

Fig.1. Geographical location of soil sample sites under sesame growing areas of Northern Telangana Zone

Laboratory analysis

The collected soil samples were analysed for different physical, physico-chemical, chemical and biological properties. Sand, silt and clay percentages were analysed by using bouycous hydrometer method (Piper,1950). Bulk density was analysed by using core sampler method (Black and Hartge,1986). Water holding capacity of soil was determined by using Keen cup (Keen Rhoezwoski,1905).

Soil pH and EC were analysed by using pH meter and EC meter with 1:2 and 1:2.5 soil water suspensions respectively. Soil organic carbon was determined by using Walkley and Black method (1934).

Available nitrogen was analysed by alkaline permanganate method (Subbiah and Asija,1956). Available phosphorus was analysed by using sodium bicarbonate method (Olsen *et al.,* 1954). Available potassium was analysed by using neutral normal ammonium acetate method (Jackson, 1973).

3. RESULTS AND DISCUSSION

Table-1: Descriptive statistics of soil variables used for soil quality assessment in HIGH sesame productivity zone

Parameters	Min	Max	Mean	Standard deviation	CV (%)	Skewness
% Sand	10.00	82.00	52.36	15.33	29.27	-0.16
% Silt	4.00	61.30	20.10	11.31	56.26	1.18
% Clay	8.60	49.00	27.48	9.88	35.95	-0.19
Bulk Density (g cm^3)	1.10	1.56	1.32	0.10	7.57	0.33
WHC (%)	30.00	56.80	46.02	6.35	13.79	-0.30
pH (1:2)	7.11	7.82	7.26	0.17	2.34	1.86
EC (1:2) (dSm^{-1})	0.32	0.46	0.47	0.13	27.65	0.75
OC (%)	0.48	1.08	0.71	0.13	18.30	0.91
Available N (kg ha^{-1})	176.20	279.70	218.59	26.79	12.25	0.02
Available P (kg ha^{-1})	13.41	82.33	41.50	15.53	37.42	0.81
Available K (kg ha^{-1})	213.00	562.00	411.86	83.85	20.35	-0.76

Table.2. Descriptive statistics of soil variables used for soil quality assessment in MEDIUM sesame productivity zone

Parameters	Min	Max	Mean	Standard deviation	CV (%)	Skewness
% Sand	28.00	88.00	62.76	14.78	23.55	-0.34
% Silt	0.50	54.50	15.00	14.24	94.93	1.78
% Clay	3.00	60.50	22.25	10.11	45.43	0.72
Bulk Density (g cm^3)	1.20	1.60	1.41	0.10	7.09	0.27
WHC (%)	20.80	56.50	41.06	9.17	22.33	-0.36
pH (1:2)	6.45	8.51	7.39	0.56	7.57	0.59
EC (1:2) (dSm^{-1})	0.32	0.56	0.41	0.07	17.07	0.67
OC (%)	0.23	0.72	0.50	0.14	28.00	-0.20
Available N (kg ha^{-1})	116.50	261.50	154.19	31.70	20.55	1.71
Available P (kg ha^{-1})	11.81	64.71	39.38	15.66	39.76	-0.06

Available K (kg ha^{-1})	126.25	585.00	332.53	100.84	30.32	0.22

Table-3: Descriptive statistics of soil variables used for soil quality assessment in LOW sesame productivity zone

Variable	Min	Max	Mean	Standard deviation	CV (%)	Skewness
% Sand	14.00	84.00	55.15	15.31	27.76	-0.85
% Silt	0.20	54.00	17.06	12.30	72.09	1.29
% Clay	15.80	43.00	27.85	6.16	22.11	0.06
Bulk Density (g cm^3)	1.20	1.63	1.43	0.12	8.39	-0.05
WHC (%)	19.60	51.70	40.16	7.02	17.48	-1.02
pH (1:2)	6.81	7.46	7.15	0.15	2.09	-0.80
EC (1:2) (dSm^{-1})	0.12	0.56	0.34	0.10	29.41	-0.43
OC (%)	0.21	0.64	0.42	0.11	26.19	-0.13
Available N (kg ha^{-1})	76.40	139.80	97.19	13.82	14.21	0.82
Available P (kg ha^{-1})	19.98	49.06	26.88	5.48	20.38	2.19
Available K (kg ha^{-1})	182.50	562.50	300.50	88.79	29.54	0.82

Texture

Soil samples were analysed for sand, silt and clay percentages and it was observed that sand ranges are from 10.00 to 82.00% with a mean value of 52.36 and CV 29.27%, from 28.00 to 88.00% with a mean value of 62.76 and CV 23.55% and from 14.00 to 84.00% with a mean value of 55.15 and CV 27.76% in high, medium and low productivity zones respectively.

Silt ranges from 4.00 to 61.30% with a mean value of 20.10 and CV 56.26%, from 0.50 to 54.50% with a mean value of 15.00 and CV 94.93% and from 0.20 to 54.00% with a mean value of 17.06 and CV 72.09% % in high, medium and low productivity zones respectively.

Clay ranges from 8.60 to 49.00% with a mean value of 27.48 and CV 35.95%, from 3.00 to 60.50% with a mean value of 22.25 and CV 45.43% and from 15.80 to 43.00% with a mean value of 27.85 and CV 22.11% in high, medium and low productivity zones respectively.

Soil texture is a permanent physical property of soil which influences many functions of soil like nutrient and water uptake (Nabiollahi *et al.,* 2020). Variations in the soil texture might be due to the difference in nature and composition of parent material. Due to the occurrence of a wide range of soil texture in the study area, it can be a substantial source of soil diversity.

Bulk density (g cm^{-3})

Collected soil samples were analysed for bulk density. It was observed that the bulk density ranges from 1.10 to 1.56 g cm^{-3} with a mean value of 1.32 and CV 7.57%, from 1.20 to 1.60 g cm^{-3} with a mean value of 1.41 and CV 7.09% and from 1.20 to 1.63 g cm^{-3} with a mean value of 1.43 and CV 8.39% in high, medium and low productivity zones respectively.

Bulk density is used for judging soil quality (Bhardwaj *et al*., 2011). The low productivity zone has significantly greater bulk density over the high and medium productivity zones, which restricts root growth and affects the transport of nutrients in the soil. This is in line with Liu *et al.* (2015). The incorporation of organic nutrient sources led to low bulk density in the high production zone. This agrees with the findings of Kathiresan (2018).

Water holding capacity (%)

Soil samples were analysed for water holding capacity and it was observed that the water holding capacity ranges from 30.00 to 56.80% with a mean value of 46.02 and CV 13.79%, from 20.80 to 56.50% with a mean value of 41.06 and CV 22.33% and from 19.60 to 51.70% with a mean value of 40.16 and CV 17.48% in high, medium and low productivity zones respectively.

The results demonstrated that significantly higher water holding capacity was found in higher sesame productivity zone soils compared to medium and low sesame growing areas of Northern Telangana zone, which may be due to organic matter addition, resulted in improved physical condition of soil and helps in maintaining better aeration for good seed germination and root growth of the crops (Shah *et al.* 2022). This is in accordance with Paul *et al.* (2014) findings.

Soil reaction

pH was determined for the samples and the results shown that the pH ranges from 7.11 to 7.82 with a mean of 7.26 and CV 2.34%, from 6.45 to 8.51 with a mean value of 7.39 and CV 7.57% and from 6.81 to 7.46 with a mean value of 7.15 and CV 2.09% in high, medium and low productivity zones respectively. This shows that the soils are alkaline in nature.

Mean soil pH values were higher in high and medium sesame productivity zones than in low sesame productivity zones, possibly due to less base leaching and the moderating impact of organic matter, which reduces the activity of exchangeable Al^{3+} ions in soil solution via chelation and the production of alumino-phosphate complexes (Hue 1992). This is supported by the previous findings of Prasad *et al.* (2023).

Electric conductivity (d Sm^{-1})

Electric conductivity was determined for the soil samples and the results shown that the EC ranges from 0.32 to 0.46 d Sm^{-1} with a mean value of 0.47 and CV 27.65%, from 0.32 to 0.56 d Sm^{-1} with a mean value of 0.41 and CV 17.07% and from 0.12 to 0.56 d Sm^{-1} with a mean value of 0.34 and CV 29.41% in high, medium and low productivity zones respectively.

The study revealed that none of the sesame growing soils have a salinity problem. Electrical conductivity values that were within the normal range could be attributed to salt leaching to lower horizons of soil due to light texture. As stated by Richard (1954), an EC value of less than 0.80 dSm^{-1} is considered normal and suitable for all crops, and the EC varies in this study from 0.12 to 0.56 dSm^{-1}, which is considered relatively safe for sesame cultivation.

Organic carbon (%)

Soil organic carbon was analysed and the results shown that the organic carbon ranges from 0.48 to 1.08% with a mean value of 0.71 and CV 18.30%, from 0.23 to 0.72% with a mean value of 0.50 and CV 28.00% and from 0.21 to 0.64% with a mean value of 0.42 and CV 26.19% in high, medium and low productivity zones respectively.

The low organic carbon content in most soils can be attributed to the prevalence of semi-arid conditions, where organic matter degrades at a faster rate, combined with little or no addition of organic manures and low vegetation cover on the fields, resulting in less likelihood of organic carbon accumulation in these soils. The similar results were also reported by Vilakar *et al.* (2021).

Available nitrogen (kg ha^{-1})

Soil samples were analysed for available nitrogen and findings are that it ranges from 176.20 to 279.70 kg ha^{-1} with a mean value of 218.59 and CV 12.25%, from 116.50 to 261.50 kg ha^{-1} with a mean value of 154.19 and CV 20.55% and from 76.40 to 139.80 kg ha^{-1} with a mean value of 97.19 and CV 14.21% in high, medium and low productivity zones respectively.

The low variability and nitrogen content are accounted for by leaching of dissolved organic nutrient and inorganic nitrogen (Verma *et al.,* 2021). Moharana *et al.* (2020) recorded low available nitrogen in soil of western plain of Rajasthan, India.

Available phosphorus (kg ha^{-1})

Soil samples were analysed for available phosphorus and findings are that it ranges from 13.41 to 82.33 kg ha^{-1} with a mean value of 41.50 and CV 37.42%, from 11.81 to 64.71 kg ha^{-1} with a mean value of 39.38 and CV 39.76% and from 19.98 to 49.06 kg ha^{-1} with a mean value of 26.88 and CV 20.38% in high, medium and low productivity zones respectively.

Comparatively higher soil available phosphorus content in high sesame productivity zones might be due to prolonged consumption of P fertilizer without testing the soil. (Satish *et al.,* 2018). Another reason for the increase in phosphorus content in the rhizosphere was the fixation of P with Ca (Rajeshwar and Mani, 2014). The lower values of available phosphorus in the low sesame productivity zone might be due to its continuous removal without matching the application of phosphorus-containing fertilizers as well as organic manures. Similar results have also been reported by Seevagan *et al.* (2020) and Bhagwan *et al.* (2023).

Available potassium (kg ha^{-1})

Soil samples were analysed for available potassium and findings are that it ranges from 213.00 to 562.00 kg ha^{-1} with a mean value of 411.86 and CV 20.35%, from 126.25 to 585.00 kg ha^{-1} with a mean value of 332.53 and CV 30.32% and from 182.50 to 562.50 kg ha^{-1} with a mean value of 300.50 and CV 29.54% in high, medium and low productivity zones respectively.

With increase in application of FYM, available potassium content increases, because potassium fixation in soil decreases due to the interaction of organic matter with clay content

(Urkurkar *et al.,* 2010). Vilakar *et al.* (2021) also reported similar results in sesame growing soils of Northern Telangana zone.

4. Conclusion:

Study revealed that the soil samples analysed were alkaline and non saline in nature in all three zones. Most of the soils are sandy clay loam. Available nitrogen content is low in all three zones (<280 kg ha^{-1}), comparitively higher in high productivity zone than medium and low productivity zones. Nitrogen fertilizers need to be applied in all the three zones. All the physical, physico-chemical and chemical properties are higher in high productivity zone except bulk density which is higher in low productivity zone which hinders the root growth and thereby decreasing the yield of the crop. On a whole, this study suggests that application of recommended dosage of fertilizers is mandatory in medium and low productivity zones.

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