J. Soils and Crops 30 (1) 132-138, June 2020

ISSN 0971-2836 (Print)
ISSN 2582-2756 (Online)
NAAS Rating - 4.46
Scientific Journal Impact Factor - 7.375

ASSESSMENT OF SOIL FERTILITY STATUS IN SELECTED VILLAGES UNDER JALYUKT SHIVAR IN NAGPUR DISTRICT

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ABSTRACT

This study on soil fertility status and to assess the nutrient indices of associated soils of selected villages in Nagpur district of Maharashtra was conducted during 2018-19. The villages under study were, Shemda and Umtha (Narkhed tahsil) and Dhurkheda (Katol tahsil) of Nagpur district, Maharashtra. Total 150 surface soil samples (0-20 cm) were collected, which includes 50 samples from each village. The Shemda, Umtha and Dhurkheda are clayey in texture, having bulk density 1.23 to 1.57 Mg m^{-3} and hydraulic conductivity 0.70 to 1.30 cm hr^{-1}. The soils were neutral to slightly alkaline in reaction with no salinity hazards. Low to moderately high in organic-C (0.20 to 0.79 %), slightly to moderately calcareous (1.00 to 5.37 %), very low to medium in available nitrogen (107.8 to 347.6 kg ha^{-1}), medium to high in phosphorus (13.0 to 35.6 kg ha^{-1}), high to very high in potassium (254.0 to 394.0 kg ha^{-1}) and low to medium in sulphur (6.65 to 20.0 mg kg^{-1}). The soils is low to medium in DTPA-extractable iron (2.11 to 9.00 mg kg^{-1}), medium to high in copper (0.18 to 1.72 mg kg^{-1}) and manganese (4.02 to 8.46 mg kg^{-1}), low to high in zinc (0.20 to 1.86 mg kg^{-1}) as per six tier system of nutrient index given by Ramamoorthy and Bajaj (1969).

The soils of Shemda, Umtha and Dhurkheda village were clayey in texture and had good physical condition, neutral to slightly alkaline in reaction (pH) with no salinity hazard. The soils are very low to medium for available nitrogen, medium to high in available phosphorus, moderately high to very high for potassium, low to moderately high in available sulphur and low to medium in DTPA extractable iron and zinc whereas, medium to high in copper and manganese, these are dependent of soil organic carbon level, which exhibits low to medium in range.

(Key words : Soil fertility, organic-C, DTPA-extractable, bulk density, soil texture, six tier system)

INTRODUCTION

Soil is the source of infinite life. It is the most precious and natural resources and not renewable in short time. Soil fertility is the dynamic natural property which can change under the influence of natural and human induced factors (Denis *et al*., 2017). Soil fertility is a function of several factors such as socio-economic, ecological and for some instance, parent material, natural inputs outputs and management practices. A report of Anonymous (2000) stated that about 20 per cent of the total cultivable land in the world is declining in soil fertility and impacting about a quarter of the world's population. Soil testing is important to recommend the fertilizer doses based on the fertility status of the soils to get good crop production. It provides information about the nutrient availability of the soil upon which fertilizers recommended for maximizing crop yield. A soil fertility status of a particular area can prove highly beneficial in guiding the farmers.

The study was done in Narkhed and Katol tahsil of Nagpur district which are selected through "Water foundation" under Jalyukt Shivar Programme of State Dept. of Agriculture.

MATERIALS AND METHODS

The survey was carried out on the soil of Shemda and Umtha villages from Narkhed tahsil and Dhurkheda village from Katol tahsil of Nagpur district. The area is almost uniform plain and topography with medium to deep black soils, formed from parent material basalt. The selected villages of both the tahsil had grown the crops in *kharif* as well as in *rabi* season. Orange, cotton and soybean are the important major crops. Other than these crops wheat, jowar, rice, tur, moong, gram also taken by the farmers.

Total 150 surface soil samples (0-20 cm) were collected from the selected villages of Nagpur district which

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includes 50 surface soil samples from each village after harvest of crops. The collected soil samples were air dried and grind with the help of mortar and pestle and sieve through 2 mm sieve and for the determination of organic carbon, soil samples further passed through 0.5 mm sieve. These soil samples were stored in polythene bags and were subsequently analyzed for mechanical parameters such as bulk density (Blake and Hartz, 1986),hydraulic conductivity (Richard, 1954) and soil texture (Bouyoucos,1936), physico-chemical parameters like pH, EC (Jackson, 1973), organic-C (Walkley and Black, 1934), $CaCO_3$ (Piper, 1966), available nitrogen (Subbiah and Asija, 1956), phosphorus (Olson and Sommer,1982), potassium (Jackson, 1973) and sulphur (Chesin and Yein, 1951) and micronutrients like Fe, Cu, Mn and Zn (Lindsay and Norvell, 1978). The soil nutrient index was assessed by using six tier system of Ramamoorthy and Bajaj (1969). The soil nutrient index was assessed by using following formula

$$NI = [NVL \times 0.5 + NL \times 1 + NM \times 1.5 + NMH \times 2 + NH \times 2.5 + NVH \times 3] \div \text{Total no. of samples}$$

Where, NVL, NL, NM, NMH, NH and NVH are the number of samples in very low, low, medium, moderately high, high and very high classes of nutrients as per six tier system.

Table 1. Rating of nutrient index value (Six tier system)

Sr. no.	Category	Value
1	Very low	0.5 to 0.75
2	Low	0.76 to 1.25
3	Moderate	1.26 to 1.75
4	Moderately high	1.76 to 2.25
5	High	2.26 to 2.75
6	Very high	2.76 to 3.00

Table 2. Critical levels of grouping of major nutrients for grouping of soils (Six tier system)

Sr. no.	Nutrient elements	Category					
		Very low	Low	Medium	Moderately high	High	Very high
1	Organic carbon (%)	<0.20	0.20 to 0.40	0.40 to 0.60	0.60 to 0.80	0.80 to 1.0	>1.0
2	Calcium carbonate (%)	<0.5	0.5 to 1.0	1.0 to 2.0	2.0 to 5.0	5.0 to 10.0	>20.0
3	Avail. N (kg ha^{-1})	<140	140 to 280	280 to 420	420 to 500	560 to 700	>700
4	Avail. P (kg ha^{-1})	<7.0	7.0 to 14.0	14.0 to 21.0	21.0 to 28.0	28.0 to 35.0	>35
5	Avail. K (kg ha^{-1})	<120	120 to 180	180 to 240	240 to 300	300 to 360	>360
6	Avail. S (mg kg^{-1})	<5	5 to 10	10 to 15	15 to 20	20 to 25	>25

RESULTS AND DISCUSSION

Physico-chemical properties

Soil texture

The analysis of soil texture was undertaken by analyzing selective 30 surface soil samples (10 samples from each village) from total 150 samples. The soils of study area are clayey in texture. The lowest content of sand was recorded at Shemda village (10.3 %) and its highest content at Dhurkheda (22.6 %). The lowest content of silt and clay was recorded at village Dhurkheda (21.6 and 48.3 %) and its highest content was recorded at Shemda (30.1 %) and Umtha (68.6 %) respectively. The soils of selected areas are developed on basaltic parent material and the soil developed on basalt produces high amount of clay on weathering (Eswaran *et al*., 1988).

Bulk density and hydraulic conductivity

The bulk density is the mass of soil volume, including pore spaces (Hillel, 2000). As the bulk density relates to combined volume of the solids and pore spaces, it serves as a guide to assess the soil porosity and compaction. It can be used as an indicator for soil aeration.

The bulk density of soils of Shemda (1.27 to 1.52 Mg m^{-3}), Umtha (1.23 to 1.52 Mg m^{-3}) and Dhurkheda (1.25 to 1.57 Mg m^{-3}) indicates the soils have good aeration. The hydraulic conductivity of Shemda, Umtha and Dhurkheda varied from 0.70 to 1.36 cm hr^{-1}, 0.70 to 1.30 cm hr^{-1} and 0.70 to 1.28 cm hr^{-1} respectively.

Soil reaction (pH) and electrical conductivity

The soil pH is an indicator of the acidity or alkalinity of soil and it is an important parameter which helps in

identification of the chemical nature of the soil (Shalini *et al.,* 2003) as it measured the hydrogen ion concentration in the soil to indicate the acidic and alkaline nature of the soil. The pH of soil varied from neutral to slightly alkaline in reaction (6.63-8.90). The pH value of Shemda, Umtha and Dhurkheda ranged from 6.63-8.10, 7.81-8.23 and 7.09-8.50 respectively (Table 3 and 4).

The electrical conductivity (EC) is the measure of the soluble salts present in the soil and is affected by cropping sequence, irrigation, land use and application of fertilizers, manures and compost (Singh *et al.,* 2016). High value of electrical conductivity represents higher degree of salinity. The electrical conductivity of Shemda, Umtha and Dhurkheda ranged from 0.21 to 0.49, 0.21 to 0.86 and 0.22 to 0.48 dS m^{-1} respectively (Table 3 and 4).

Organic carbon

The organic carbon content of Shemda, Umtha and Dhurkheda ranged from 0.22-0.73, 0.20-0.38 and 0.25-0.79 per cent respectively. The organic carbon content of selected villages varied from low to moderately high in category (Table 3 and 4). Similar result was found by Meena *et al.* (2006). They observed that the organic carbon content was low (<0.50) in 63 per cent soil samples, medium (0.50 to 0.75) in 21 per cent and high (>0.75) in 16 per cent soil samples in light texture soils of Tonk district, Rajasthan.

Calcium carbonate (%)

The $CaCO_3$ content of Shemda varied from 1.30-4.52 per cent, which indicates that the soils were slightly to moderately calcareous in nature, Umtha ranged from 1.0-5.0 per cent and Dhurkheda 2.12-5.37 per cent (Table 3 and 4). Similar results were reported by Lakde, (2011), from Bhiwapur tahsil of Nagpur district and found that the highest value of $CaCO_3$ (11.75 per cent) in Borgaon-Rongha series, whereas lowest value (1.58 per cent) in Linga-Panjara series with mean value of 3.51 per cent

Available macronutrients

The available nitrogen was low in major portion having the range of 107.8-347.6 kg ha^{-1} as per six tier system of nutrient index. The nitrogen content in Shemda, Umtha and Dhurkheda categorized from 107.8-321.2 kg ha^{-1}, 102.9-299.2 kg ha^{-1} and 122.5-347.6 kg ha^{-1} respectively. According to Amara *et al.* (2017), variation in nitrogen content may relate to soil management, application of FYM and fertilizers to crop. The nitrogen content in soils is dependent on temperature, rainfall and altitude.

Phosphorus is essential for growth, cell division, root growth, fruit development and early maturity of the crops. It is also required for energy storage and transfer being a constituent of several organic compounds including oils and amino acids. The level of phosphorus in study area was medium to high in category (13.0-35.6 kg ha^{-1}) i.e. in Shemda it was 14.3-32.9 kg ha^{-1}, for Umtha 13.0-30.6 kg ha^{-1} and for Dhurkheda it was 16.3-35.6 kg ha^{-1}.

Shukla (2011) found that the available potassium content generally medium to high in range. The selected villages falls under moderately high to very high in potassium content i.e. in Shemda (266.8-392.0 kg ha^{-1}), Umtha (254.0-380.8 kg ha^{-1}) and Dhurkheda (265.0-394.0 kg ha^{-1}).

The available sulphur was low to moderately high as per six tier system. The sulphur content of Shemda, Umtha and Dhurkheda ranged from 9.67-18.21, 10.08-20.0 and 6.65-16.96 mg kg^{-1} respectively (Table 5 and 6). The low and medium levels of available sulphur in soils of the study area might be due to lack of sulphur addition and continuous removal of sulphur by crops (Balanagoudar, 1989).

DTPA-extractable micronutrients

The DTPA-extractable iron of selected villages Shemda, Umtha and Dhurkheda was categorized under low to medium in range (2.11-9.00 mg kg^{-1}). The copper content was low to very high (0.18-1.72 mg kg^{-1}) and the manganese content was moderately high to high (4.02-8.46 mg kg^{-1}). Whereas, the zinc content was in very low to moderately high (0.20-1.86 mg kg^{-1}) as per six tier system of nutrient index (Table 7 and 8).

Soil fertility index and soil fertility class

The nutrient indices of soils were worked out and six tier system of soil nutrient index were assessed by using the scale of Ramamoorthy and Bajaj (1969).

Soil nutrient index ratings

Considering the nutrient index values six tier system of soil organic carbon of Ramamoorthy and Bajaj (1969) all the selected villages i.e. Shemda, Umtha and Dhurkheda are moderate in category i.e., 1.42, 1.27 and 1.43 respectively. The nutrient index values of six tier system of nitrogen for all the selected villages were low in category (i.e. Shemda, Umtha and Dhurkheda are 0.98, 0.90 and 1.00 as per six tier system respectively). The nutrient index values of available potassium were 2.26, 2.30 and 2.12 for Shemda, Dhurkheda and Umtha respectively which falls under high category. The nutrient index ratings for sulphur content were categorized under moderate category i.e., 1.65, 1.67 and 1.55 of Shemda, Umtha and Dhurkheda respectively.

Considering the nutrient index values of six tier system for DTPA-extractable iron (Ramamoorthy and Bajaj, 1969) of Shemda and Umtha was moderate in category i.e., 1.37 and 1.44, while Dhurkheda was low in category (1.23). The soil of Shemda village for DTPA-extractable copper was categorized under moderately high in category for copper i.e., 1.89, 1.97 and 1.95 respectively. DTPA-extractable manganese for all the selected villages i.e. Shemda, Umtha and Dhurkheda were moderately high i.e., 2.00, 2.02 and 2.01 respectively. The DTPA-extractable zinc was moderate in all the selected villages i.e., 1.35, 1.32 and 1.32 respectively.

Table 3. Classes of soil organic carbon and $CaCO_3$ in the soil of selected villages of Nagpur district

Organic carbon class	Organic carbon (%)	No. of samples		
		Shemda	Umtha	Dhurkheda
I (Very low)	<0.20	00	00	00
II (Low)	0.20-0.40	18	27	15
III (Medium)	0.40-0.60	22	19	27
IV(Moderate high)	0.60-0.80	10	04	08
V (High)	0.80-1.00	00	00	00
VI (Very high)	>1.00	00	00	00
$CaCO_3$ class	**Available $CaCO_3$ (%)**	**No. of samples**		
		Shemda	**Umtha**	**Dhurkheda**
I (Non calcareous)	<0.5	00	00	00
II (Rarely calcareous)	0.5-1.0	00	00	00
III (Slightly calcareous)	1.0-2.0	07	27	00
IV (Moderately calcareous)	2.0-5.0	43	23	41
V (Calcareous)	5.0-10.0	00	00	09
VI (Very Calcareous)	>20.0	00	00	00

Table 4. Statistical data of physico-chemical properties of selected villages of Nagpur district

Properties	No. of farmers	pH		EC dSm^{-1}		$CaCO_3$ (%)		OC (%)	
Village		Range	Mean	Range	Mean	Range	Mean	Range	Mean
Shemda	50	7.25-8.10	7.71	0.21-0.49	0.35	1.30-4.52	2.93	0.22-0.73	0.46
Umtha	50	7.21-8.30	7.70	0.21-0.86	0.45	1.0-5.0	2.38	0.20-0.68	0.40
Dhurkheda	50	7.09-8.50	7.75	0.22-0.48	0.33	2.12-5.37	4.04	0.25-0.79	0.46

Table 5. Classification of soils of selected villages of Nagpur district for available N, P, K and S

Available N class	Available N (kg ha^{-1})	No. of samples		
		Shemda	Umtha	Dhurkheda
I (Very low)	<140	04	14	06
II (Low)	140-280	44	32	38
III (Medium)	280-420	02	04	06
IV (Moderate high)	420-560	00	00	00
V (High)	560-700	00	00	00
VI (Very high)	>700	00	00	00
Available P class	**Available P(kg ha^{-1})**	**No. of samples**		
		Shemda	**Umtha**	**Dhurkheda**
I (Very low)	<7.0	00	00	00
II (Low)	7.0-14.0	00	04	00
III (Medium)	14.0-21.0	25	22	21
IV (Moderate high)	21.0-28.0	21	21	22
V (High)	28.0-35.0	04	03	07
VI (Very high)	>35.0	00	00	00
Available K class	**Available K (kg ha^{-1})**	**No. of samples**		
		Shemda	**Umtha**	**Dhurkheda**
I (Very low)	<120	00	00	00
II (Low)	120-180	00	00	00
III (Medium)	180-240	00	00	00
IV (Moderate high)	240-300	30	23	39
V (High)	300-360	14	24	10
VI (Very high)	>360	06	03	01

Available N class	Available N (kg ha^{-1})	No. of samples		
		Shemda	Umtha	Dhurkheda
I (Very low)	<5	00	00	00
II (Low)	5-10	01	00	09
III (Medium)	10-15	33	33	27
IV (Moderate high)	15-20	16	17	14
V (High)	20-25	00	00	00
VI (Very high)	>25	00	00	00

Table 6. Range and average of available macronutrients of selected villages of Nagpur district

Properties	No. of farmers	Macronutrient							
		Nitrogen		Phosphorus		Potassium		Sulphur	
Village		Range	Mean	Range	Mean	Range	Mean	Range	Mean
Shemda	50	107.8-321.2	208.25	14.3-32.9	22.60	266.8-392.0	334.23	9.67-18.21	13.92
Umtha	50	102-9-299.2	187.98	13.0-30.6	20.82	254.0-380.8	307.72	10.08-20.0	13.88
Dhurkheda	50	122.5-347.6	209.85	16.3-35.6	22.57	265.0-394.0	326.36	6.65-16.96	12.79

Table 7. Classification of soils of selected villages of Nagpur district for DTPA- extractable micronutrients

Available- Fe class	Available Fe(mg kg^{-1})	No. of samples		
		Shemda	Umtha	Dhurkheda
I (Very low)	<2.50	00	00	00
II (Low)	2.50-4.50	13	06	27
III (Medium)	4.50-9.0	37	44	23
IV (Moderate high)	9.0-18.0	00	00	00
V (High)	18.0-27.0	00	00	00
VI (High)	>27	00	00	00
Available- Cu class	**Available Cu(mg kg^{-1})**	**No. of samples**		
		Shemda	Umtha	Dhurkheda
I (Very low)	<0.10	00	00	00
II (Low)	0.11-0.20	01	00	00
III (Medium)	0.20-0.40	14	09	12
IV (Moderate high)	0.41-0.80	25	32	33
V (High)	0.81-1.20	09	06	03
VI (High)	>1.20	02	00	02
Available- Mn class	**Available Mn(mg kg^{-1})**	**No. of samples**		
		Shemda	Umtha	Dhurkheda
I (Very low)	<1	00	00	00
II (Low)	1-2	00	00	00
III (Medium)	2-4	00	00	00
IV (Moderate high)	4-8	50	48	49
V (High)	8-16	00	02	01
VI (High)	>16	00	00	00
Available- Zn class	**Available Zn(mg kg^{-1})**	**No. of samples**		
		Shemda	Umtha	Dhurkheda
I (Very low)	<0.30	06	04	05
II (Low)	0.30-0.60	13	18	21
III (Medium)	0.60-1.20	24	20	11
IV(Moderate high)	1.20-1.80	07	08	13
V (High)	1.80-2.40	00	00	00
VI (Very high)	>2.40	00	00	00

Table 8. Range and average of micronutrients of selected villages of Nagpur district

Properties	No. of farmers	Macronutrient (mg kg^{-1})							
		Fe		Cu		Mn		Zn	
Village		Range	Mean	Range	Mean	Range	Mean	Range	Mean
Shemda	50	3.23-8.95	5.59	0.18-1.29	0.56	4.05-7.72	5.40	0.20-1.56	0.75
Umtha	50	3.26-9.00	6.18	0.23-0.98	0.58	4.04-8.46	5.76	0.22-1.86	0.75
Dhurkheda	50	2.11-6.67	4.31	0.20-1.72	0.58	4.02-8.14	5.69	0.21-1.78	0.74

Table 9. Soil fertility index and fertility class of selected villages Nagpur district (Six tier system)

Nutrient	Fertility index	Category
Soil nutrient index of Shemda village		
Organic carbon	1.42	Moderate
Avail. N	0.98	Low
Avail. P	1.79	Moderately high
Avail. K	2.26	High
Avail. S	1.65	Moderate
DTPA- Fe	1.37	Moderate
DTPA- Cu	1.89	Moderately high
DTPA- Mn	2.00	Moderately high
DTPA- Zn	1.35	Moderate
Soil nutrient index of Umtha village		
Organic carbon	1.27	Moderate
Avail. N	0.90	Low
Avail. P	1.73	Moderate
Avail. K	2.30	High
Avail. S	1.67	Moderate
DTPA- Fe	1.44	Moderate
DTPA- Cu	1.97	Moderately high
DTPA- Mn	2.02	Moderately high
DTPA- Zn	1.32	Moderate
Soil nutrient index of Dhurkheda village		
Organic carbon	1.43	Moderate
Avail. N	1.00	Low
Avail. P	1.86	Moderately high
Avail. K	2.12	Moderately high
Avail. S	1.55	Moderate
DTPA- Fe	1.23	Low
DTPA- Cu	1.95	Moderately high
DTPA- Mn	2.01	Moderately high
DTPA- Zn	1.32	Moderate

The soils of Shemda and Umtha from Narkhed tahsil and Dhurkheda from Katol tahsil of Nagpur district were clayey in texture and had good physical condition, neutral to slightly alkaline in reaction (pH) with no salinity hazard. The soils are very low to medium for available nitrogen, medium to high in available phosphorus, moderately high to very high for potassium, low to moderately high in available sulphur and low to medium in DTPA extractable iron and zinc whereas, medium to high in copper and manganese, these are dependent of soil organic carbon level, which exhibits low to medium in range.

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