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Assessment of available soil nutrient status in black soils of Akola district, Maharashtra

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Abstract

The present study was conducted during the year 2016 and 2017 at Department of Soil Science and Agricultural Chemistry, Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra with an aim to know the fertility status of soils of Western part of the Central Research Station, Dr. PDKV Akola. Grid based (GPS) seventy three surface (0-20 cm) soil samples were collected by systematic survey from three blocks and analyzed as per standard procedure for assessing chemical properties and available nutrient status of soil. The results indicate that all the soils under study were slightly alkaline to moderately alkaline in reaction and it ranged from 7.6 to 8.5 and soils were free from soluble salt hazard (EC 0.12 to 0.5 dSm^{-1}). Organic carbon content ranged from 3.9-8.4 g kg^{-1}, soils of all the three blocks were moderately calcareous to calcareous due to presence of $CaCO_3$ in soil. In context of nutrient status of Western part of CRS, soils were low to medium in available nitrogen (145.8 to 371.28 kg ha^{-1}), medium in available phosphorus (13.98 to 20.16 kg ha^{-1}) and high to very high in available potassium (264.3 to 358.4 kg ha^{-1}) and low to medium in available sulphur (7.45 to 14.26 mg kg^{-1}) content.

Keyword: Correlation, fertility status, grid survey, GPS, physico-chemical property, macronutrients

Introduction

Soil is a vital resource, can be termed as ‘Soul of infinite life’. The essence of life in the soil is its crop producing capacity i.e. the soil productivity largely depends on soil fertility, management practices and climate. These agricultural practices can be managed, while the climate is natural factor which influences the soil fertility. Therefore, soil fertility is the major component of productivity which primarily deals with nutrient supplying capacity of the soil to the plant. Therefore, it has been always considered to carry out genetic study as well as to find out fertility evaluation for making best use of the soil for crop production.

Ensuring food security for the ever-increasing world population has direct relation with physicochemical property, fertility and productivity of soil. The overall productivity and sustainability of a given agricultural sector is highly dependent up on the fertility and physicochemical characteristics of soil resources (Wakene, 2001; Mohammed *et al*., 2005). According to IFPRI (2010), the major causes of nutrient depletion include farming without replenishing nutrients over time (loss through continuous crop harvest), removal of crop residue, low level of fertilizer use and unbalanced application of nutrients. Soil characterization in relation to evaluation of fertility status of the soils of an area is an important aspect in context of sustainable agricultural production (Singh and Mishra, 2012).

Soil fertility maps are meant for highlighting the nutrient needs, based on fertility status of soils to realize good crop yields. Obviously, a soil fertility map for a particular area can prove highly beneficial in guiding the farmers, manufactures and planners in ascertaining the requirement of various fertilizers in a season/ year and making projections for increased requirement based on cropping pattern and intensity. Therefore, the present investigation was undertaken to assess the soil soil available nutrient status in black soils of Akola district.

Materials and Methods

The central research station is situated about 2 km east of Akola town. It is located at longitude 77°02'44" to 77°04'59"E, Latitude 20°45'15" to 20°43'18" N. The research station extends over an area of 1145 hectares. The western part of central research station Dr. PDKV, Akola includes three blocks viz., Gudadhi block, Shivar block and Western block. Total 73 surface soil samples (0-20 cm) from cultivated area of the western part of central research station Dr. PDKV, Akola were collected using Global Positioning System (GPS) at grid interval of 220 m. The collected soil samples were processed and analyzed for their nutrient status by standard analytical methods.

Sieved soil samples were determined for pH and electrical conductivity at 1:2.5 soil water suspensions (Jackson 1973) [4]. Organic carbon was measured by Chromic acid wet digestion method (Walkley and Black 1934). And $CaCO_3$ was determined by rapid titration method (Piper 1966) [11]. Available N was determined by alkaline permanganate method as described by Subbiah and Asija (1956) [13], the available P was extracted with Olsen's reagent 0.5 M $NaHCO_3$ of pH 8.5 and was estimated color imetrically as per Jackson (1973) [4], the available K was estimated by extracting the soil with 1 N NH_4OAC (pH 7.0) by using flame photometer (Jackson, 1973) [4] and Available sulphur was estimated by 0.15% $CaCl_2$ extractable method (Piper, 1966) [11].

Results and Discussion

The results presented in (Table 1 and Fig.1) revealed that the pH of the soils of Gudadhi block ranged from 7.84 to 8.2 indicating slightly to moderately alkaline in reaction. In Shivar block it ranged from 7.9 to 8.57 and in western block it ranged from 7.6 to 8.3. The highest pH value of 8.6 was recorded in soils of Shivar block and lowest pH value of 7.62 in western block. The alkaline reaction of soil is probably due to presence of sufficient free lime content in these soils (Jibhkate *et al*., 2009) [5]. The EC ranged from 0.2 to 0.5 dSm^{-1} in Gudadhi, in western block it ranged from 0.15 to 0.46 dSm^{-1} and in Shivar block it ranged from 0.1 to 0.3 dSm^{-1}. As regards the variation observed in respect of electrical conductivity of surface soils no definite trend was observed. This range of EC value shows that all the soils were non-saline in nature and suitable for healthy plant growth. The EC value <1.0 indicate that these soils are free from hazard of soluble salts as prescribed by Richards (1954). The organic carbon in soils of Gudadhi block ranged from 3.9 to 8.4 g kg^{-1}, in western block it ranged from 3.3 to 6.9 g kg^{-1} and in Shivar block it ranged from 3.3 to 6.6 g kg^{-1}. The soils were low to moderately high in organic carbon content in all three blocks. The surface of any soil normally received continuous fresh addition of organic matter due to residues as well as this

Table 1: Soil pH, EC, organic carbon and Ca CO_3 status of study area

Blocks	No. of samples analysed	Parameters	Range	Mean	Ratings					
					VL	L	M	Mod.	H	VH
Gudadhi	35	pH	7.84-8.2	7.9	-	-	-	-	-	-
		EC	0.2-0.5	0.3	-	-	-	-	-	-
		OC(g kg^{-1})	3.9-8.4	5.5	0	2 (6%)	23 (65%)	9 (26%)	1 (3%)	0
		$CaCO_3$ (%)	4-5.13	4.5	0	0	0	33 (93%)	2 (7%)	0
Western	20	pH	7.62-8.32	7.91	-	-	-	-	-	-
		EC	0.15-0.46	0.23	-	-	-	-	-	-
		OC(g kg^{-1})	3.3-6.9	5.2	0	4 (20%)	12 (60%)	4 (20%)	0	0
		$CaCO_3$ (%)	3.38-5.19	4.4	0	0	0	19 (95%)	1 (5%)	0
Shivar	18	pH	7.92-8.57	8.19	-	-	-	-	-	-
		EC	0.12-0.30	0.20	-	-	-	-	-	-
		OC(g kg^{-1})	3.3-6.6	5.3	0	3 (17%)	12 (66%)	6 (33%)	0	0
		$CaCO_3$ (%)	3.56-6.25	5.05	0	0	0	7 (39%)	11 (61%)	0

layer also receives addition of organic matter in the form of FYM, it might be the reason for higher content of organic carbon in surface layer. The low content of organic carbon might be due to slow rate of decomposition and continuous utilization by plants for the uptake of nutrients. Similar results were reported by Patil *et al*. (2008) [10] in the soils of Agriculture college farm Pune. The data revealed that all the soils under study contain free lime and this might be reason why these soils are moderately alkaline in reaction. The magnitude of free lime content in Gudadhi block ranged from 4 to 6.28 %, in western block and it ranged from 3.37 to 5.19 % and in Shivar block it ranged between 4 to 5.13 %. It indicates that these soils are moderately calcareous to calcareous in nature.

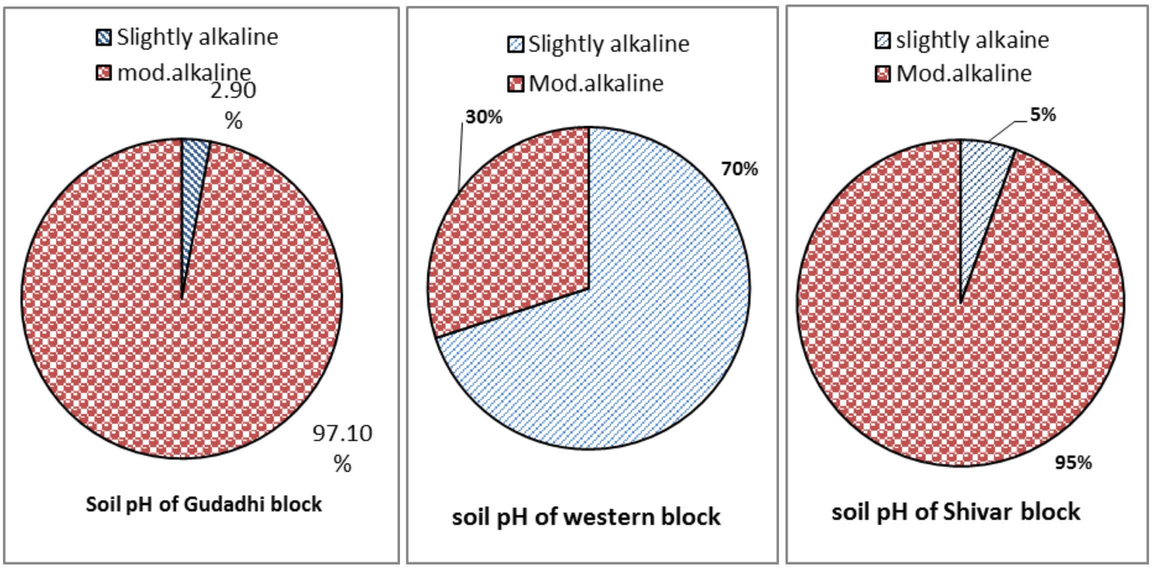
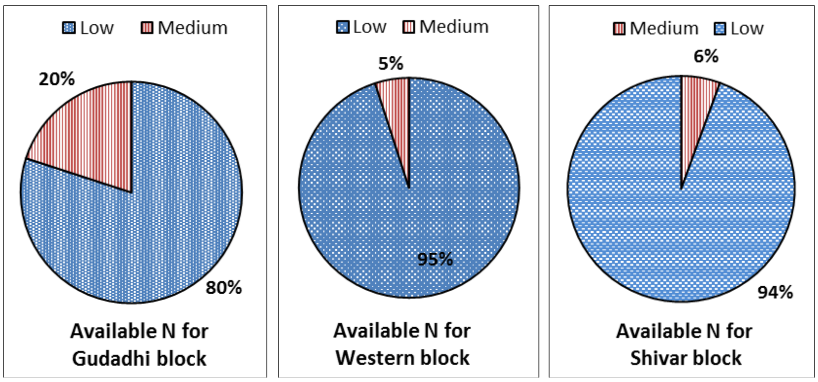


Fig 1: Categorization of soil pH from Western part of the CRS Dr PDKV Akola

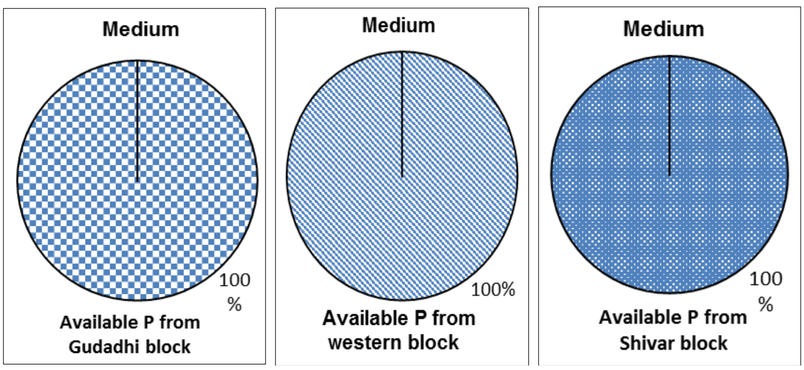
The data presented in (Table 2 and Fig.2) revealed that the available nitrogen in Gudadhi block ranged from 172.38 - 371.28 kg ha^{-1}, western block ranged from 145.86 - 304.98 kg ha^{-1} and in Shivar block ranged from 145.8 - 291.72 kg ha^{-1}. The available N content of soils depends on the mineralization of organic matter and management practices including cropping pattern. The low available nitrogen might be due to the less addition of FYM and high available N content may be due to the fixation of nitrogen by pulse crops grown in sequence such as soya bean and pigeonpea. Similar observations were also recorded by Dhale and Prasad (2009) [3]. As per rating standard, soil containing less than 280 kg nitrogen ha^{-1} are normally rated as low in available nitrogen content. The soils thus need judicious application of both organic manure and nitrogenous fertilizers to meet the N requirement of crops grown in them. The available phosphorus ranged from 14.2 to 17.7 kg ha^{-1} in Gudadhi block. In Western block it ranged from 14.25 to 20.15 kg ha^{-1} and in Shivar block it ranged from 13.98 to 19.80 kg ha^{-1}. Low available P might be because of less mobility of phosphorus in the soil as it get easily adsorbed and fixed in upper layer, medium availability may due to the cropping system. Similar observation was recorded by Dhale and Prasad (2009) [3]. The magnitude of available potassium for Gudadhi block soil ranged from 268.8 to 358.4 kg ha^{-1}, Western block it ranged from 278.88 to 358.4 kg ha^{-1} and in Shivar block it ranged from 264.32 to 338.21 kg ha^{-1}. As per ratings, soils containing available potassium more than 300 kg ha^{-1} categorised as very high in available potassium content. The data on the basis of available potassium content indicates that the soils have no problem of K deficiency. The high potassium content may be attributed to presence of potassium supplying minerals in parent rock of the area. Similar results were also reported by Kashikar (1983) [7]; NBSS and LUP (1986) for black soils. The magnitude of available sulphur for Gudadhi block soil ranged from 7.51 to 14.26 mg kg^{-1}, western block it ranged from 8.12 to 12.19 mg kg^{-1} and in Shivar block ranged from 7.45 to 12.34 mg kg^{-1}. As per ratings, soils containing available sulphur more than 20 mg kg^{-1} categorized as very high in available sulphur content. Low available sulphur in these soils may be due to the less supply of sulphur containing fertilizers.

Table 2: Soil available nutrient status in three blocks of study area

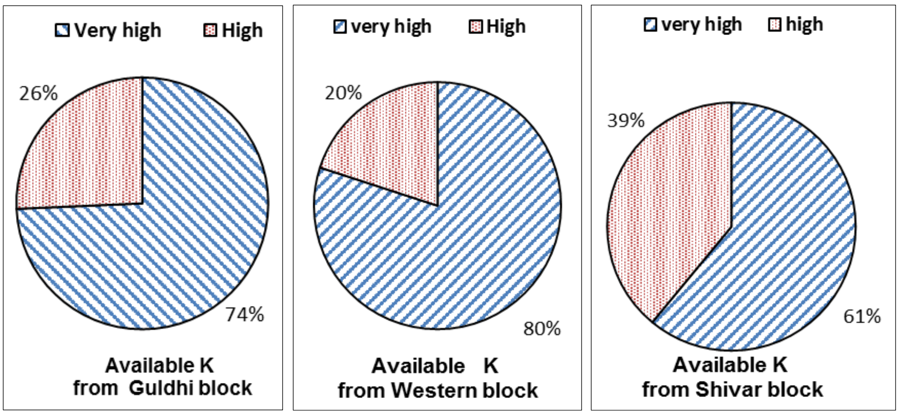
Blocks	No. of samples analysed	Para meters	Range (kg ha^{-1})	Mean (kg ha^{-1})	Ratings				
					L	M	Mod	H	VH
Gudadhi	35	N	172.3-371.28	245.88	28 (80%)	7 (20%)	0	0	0
		P	14.3-17.7	15.3	0	35 (100%)	0	0	0
		K	268.8-358.4	310.37	0	0	0	9 (25.7%)	26 (74.3%)
		S	7.51-14.26 (mg kg^{-1})	10.14	15 (43%)	20 (57%)	-	0	-
Western	20	N	145.8-304.98	232.05	19 (95%)	1 (5%)	0	0	0
		P	14.25-20.16	16.01	0	20 (100%)	0	0	0
		K	278.8-358.4	321.12	0	0	0	4 (20%)	16 (60%)
		S	9.27-13.12 (mg kg^{-1})	11.07	2 (10%)	18 (90%)	-	0	-
Shivar	18	N	145.8-291.72	232.79	17 (94.4%)	1 (5.6%)	0	0	0
		P	13.98-19.80	16	0	18 (100%)	0	0	0
		K	264.3-338.2	303.58	0	0	0	7 (39%)	11 (61%)
		S	7.45-12.34 (mg kg^{-1})	10.23	7 (39%)	11 (61%)	-	0	-



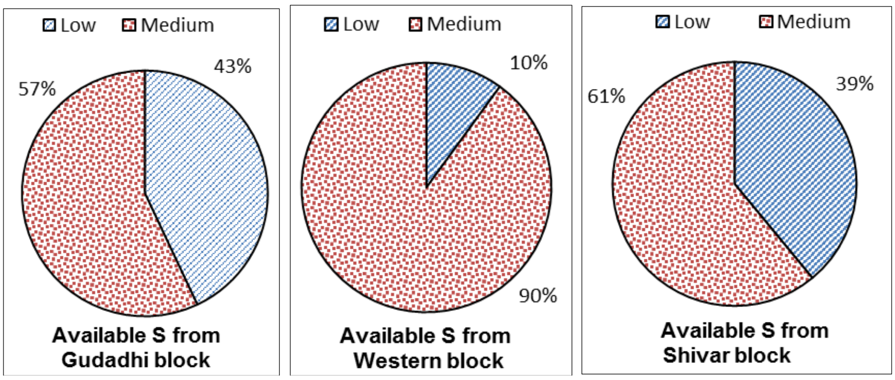
Categorisation of Available Nitrogen



Categorisation of Available Phosphorus



Categorisation of Available potassium



Categorisation of Available Sulphur

Fig 2: Categorisation of available major nutrients from Western part of the CRS

Table 3: Correlation between the Physico-chemical properties and available nutrients in Gudadhi block of Western part of the CRS Dr. PDKV Akola

	pH	EC	OC	$CaCO_3$	N	P	K	S
pH	1							
EC	-0.181	1						
OC	0.17	-0.232	1					
$CaCO_3$	0.013	0.037	0.202	1				
N	0.197	-0.251	0.988**	0.224	1			
P	0.007	0.121	0.421*	0.307	**0.377***	1		
K	-0.22	0.156	0.197	0.135	0.18	0.109	1	
S	0.011	-0.084	0.02	0.102	-0.015	-0.009	0.041	1

In Gudadhi block statistical correlation ship showed significant and positive correlation of available N and available P with organic carbon which is evident by ‘r’ values of 0.988** and 0.421* respectively (Table 3). Availability of P showed positive and significant relationship with available nitrogen which was evident by ‘r’ value 0.377.Similar results were observed by Chinchmalatpure *et al.* (2000) [2]. The significant and positive correlation between organic carbon and available nitrogen could be because of release of mineralizable nitrogen from soil organic matter in proportionate amounts (Vanilarasu and Balakrishnamurthy, 2014) [15] and adsorption of NH4 –N by humus complexes in soil. The results are in conformity with those of Kumar *et al.* (2014) [8]

Table 4: Correlation between the Physico-chemical properties and available nutrients in Western block of Western part of the CRS Dr. PDKV Akola

	pH	EC	OC	$CaCO_3$	N	P	K	S
pH	1							
EC	-0.298	1						
OC	0.069	-0.153	1					
$CaCO_3$	-0.12	0.045	-0.088	1				
N	0.048	-0.191	0.924**	-0.154	1			
P	0.313	-0.046	-0.168	-0.585**	-0.106	1		
K	-0.02	0.416	-0.171	-0.216	-0.146	0.231	1	
S	0.129	-0.325	0.424	-0.027	0.482*	0.156	0.298	1

*****Significant at 5% level of significance
** Significant at 1% level of significance

In Western block statistical correlation ship showed positive and significant correlation of available N with organic carbon indicated that availability of N increased with increase in organic carbon in soil (Table 4). It was observed that available S showed positive and significant relation with available N(r =0.482*) in the soil. Similar results were observed by Katkar *et al.* (2013) [6]. The significant and positive correlation between organic carbon and available nitrogen could be because of release of mineralizable nitrogen from soil organic matter in proportionate amounts (Vanilarasu and Balakrishnamurthy, 2014) [15] and adsorption of NH4 –N by humus complexes in soil. The results are in conformity with those of Kumar *et al*. (2014) [8]. The significant and positive correlation between organic carbon and available phosphorus might be due to acidulating effect of organic carbon, formation of easily accessible organophosphate complexes, release of phosphorus from organic complexes and reduction in phosphorus fixation by humus due to formation of coatings on iron and aluminum oxides. The results are in harmony with the findings of Ayele *et al*. (2013) [1] and Singh *et al*. (2014).

Table 5: Correlation between the Physico-chemical properties and available nutrients in Shivar block of Western part of the CRS Dr. PDKV Akola

	pH	**EC**	**OC**	**$CaCO_3$**	**N**	**P**	**K**	**S**
pH	1							
EC	0.388	1						
OC	-0.038	-0.276	1					
$CaCO_3$	0.167	-0.136	0.298	1				
N	-0.062	-0.384	**0.968****	0.293	1			
P	0.101	0.177	-0.246	-0.153	-0.224	1		
K	-0.234	-0.18	-0.061	0.318	-0.044	0.327	1	
S	0.014	-0.104	0.321	-0.022	0.358	-0.164	0.097	1

*****Significant at 5% level of significance
** Significant at 1% level of significance

In Shivar block the significant positive correlation was observed between available N and organic carbon (r=0.968**). The varied relationship among the physico-chemical properties and available nutrients might due to the different cropping systems in western part of the CRS, Dr. PDKV, Akola (Table 5). The significant and positive correlation between organic carbon and available nitrogen could be because of release of mineralizable nitrogen from soil organic matter in proportionate amounts (Vanilarasu and Balakrishnamurthy, 2014) [15] and adsorption of NH4 –N by humus complexes in soil. The results are in conformity with those of Kumar *et al*. (2014) [8].

Conclusion:

Soils of Gudadhi block, Western and Shivar block are slightly to moderately alkaline in reaction having EC within the safe limit for crop cultivation. The organic carbon content in these soils was low to high and is moderately calcareous to calcareous in nature. The soils of Gudadhi block, Western and Shivar block were low to medium in available nitrogen and medium in phosphorus and high to very high in available potassium status and low to medium in available sulphur. In the soils of Gudadhi, Western and Shivar block the availability of nitrogen, phosphorus increased with increase in organic carbon content. Calcium carbonate increased with increase in soil pH and organic carbon. Availability of sulphur increased with increase in available nitrogen. Data showed that available N status of western part of CRS soils was categorized under low fertility status hence there is a need in increment of recommended dose of fertilizer for the crops by 25% and status of available P and S were categorized as medium and available K categorized as very high and hence the fertilizer doses should be as per the recommendations.

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