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Evaluation of nutrient index value for micronutrients in black soils of Akola district of Maharastra, India

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Abstract
The present study was conducted during the year 2015-17 at Department of Soil Science and Agricultural Chemistry, Dr PDKV Akola, Maharashtra with aim to know the NIV value and micronutrient status of soils of Western part of the Central Research Station, Dr. PDKV Akola, Maharashtra. Grid based (GPS) seventy three surface (0-20 cm) soil samples by systematic survey were collected from three blocks and analyzed as per standard procedure for assessing chemical properties and available micronutrient status. The study revealed that the Western part of the CRS soils showed very low to moderately high iron content (1.66 to 10.63 mg kg^{-1}). The available Mn content was low to medium, it ranged from 1.5 to 9.39 mg kg^{-1}. These soils showed very low to medium available Zn content and it ranged from 0.21 to 1.18 mg kg^{-1}. Available Cu in these soils was medium to high and it ranged from 0.26 to 4.26 mg kg^{-1}.Considering soil nutrient index values the soils of CRS showed low NIV for available Zn and high NIV for available Fe, Cu and Mn. Further with increase in EC of soil, availability of Cu decreased, whereas, availability of Mn increased and as P and $CaCO_3$ increased availability of Zn decreased.

Keywords: Correlation, fertility status, grid survey, micronutrients, nutrient index

1. Introduction
The micronutrient are essential for the proper biochemical transformations within the plant body, so as to yield the desired end products, Zn is essential for protein and auxin production, cu is a constituent of cytochrome oxidase, Fe helps in photosynthesis while Mn is essential for photosynthesis, carbon assimilation and nitrogen metabolism. Soil fertility is one of the important factors controlling yield of the crops. Soil characterization in relation to evaluation of fertility status of the soil of an area or region is an important aspect in context of sustainable agricultural production because of imbalanced and inadequate fertilizer use coupled with low efficiency of other inputs, the response (production) efficiency of chemical fertilizer nutrients has declined tremendously under intensive agriculture in recent years (Yadav and Meena, 2009) [13]. Keeping these in view and also lack of information on micronutrients status to identify the emerging micronutrient deficiency or toxicity in the soils, a comprehensive study was undertaken for assessment of micronutrient status of soils and their relation with some chemical properties of soils of Western part of the Central Research Station Dr. PDKV Akola, Maharashtra.

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. Gudadhi block is having cultivated area 109 ha, Western block is having 43.8 ha and area under Shivar block is 22.4 ha. The crops grown in the Western part of the CRS were sorghum, cotton, soybean, greengram, pigeonpea, jute, sunhemp, safflower, sugarcane and sunflower. 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 of interval 220 m. The collected soil samples were processed and analyzed for their nutrient status by standard analytical methods (Jackson, 1973) [2]. The micronutrients in these soil samples were extracted

with DTPA solution (Lindsey and Norvell, 1978) [8] with the help of Atomic Absorption Spectrophotometer.

The soil nutrient index was calculated according to the procedure given by Ramamoorthy and Bajaj (1969) [10].

$$\text{Nutrient Index Value} = \frac{(\text{No. of samples in low}\times 1) + (\text{No. of samples in medium}\times 2) + (\text{No. of Samples in high}\times 3)}{\text{No. of Samples taken}}$$

Table 1: Ratings of Nutrient index value for micronutrients

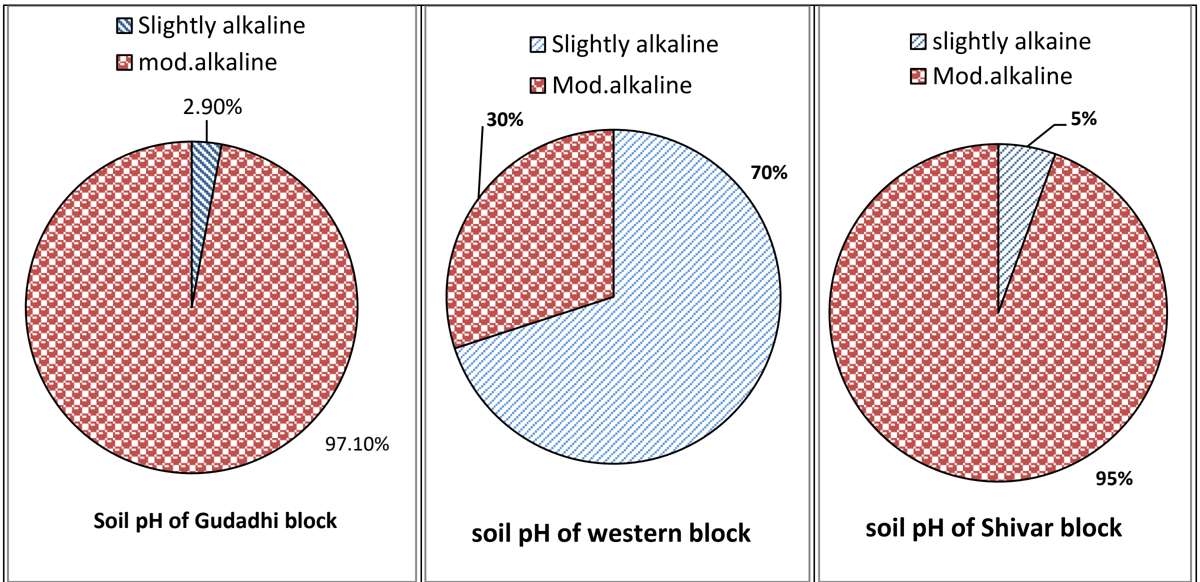
Sr. No.	Category	Value
1	Low	<1.67
2	Medium	1.67-2.33
3	High	>2.33

Results and Discussion

The result of study indicated that all the soil samples from western part of Central Research Station Dr. PDKV Akola were slightly alkaline to alkaline in soil reaction and within safe limit of EC. 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 (table no.2). The alkaline reaction of soil is probably due to presence of sufficient free lime content in these soils (Jibhkate *et al*., 2009) [3].

Table 2: Soil pH, EC, organic carbon and $CaCO_3$ 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



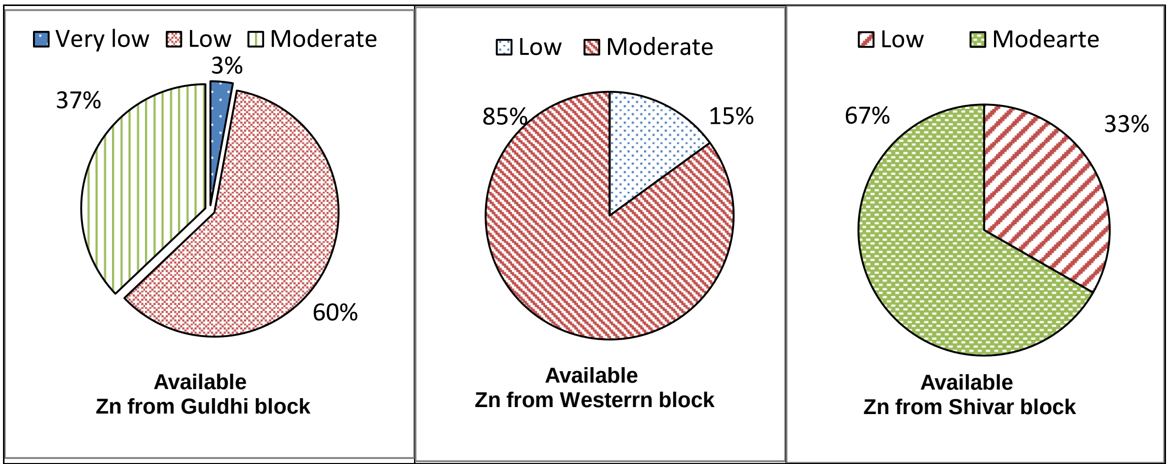
ategorisation of soil pH

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

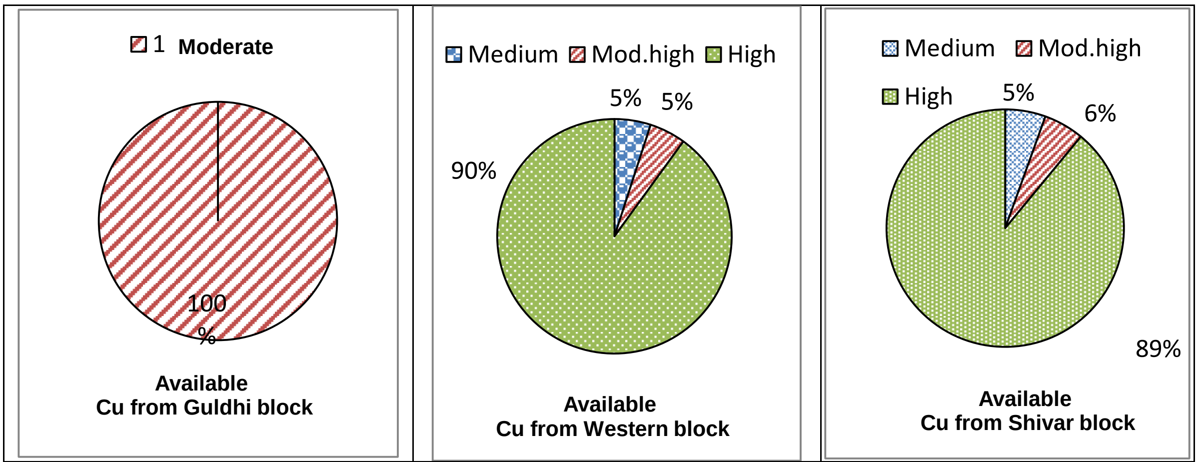
The available zinc extracted by DTPA varied from 0.21 to 1.0 mg kg^{-1} for Gudadhi block, for Western block it ranged from 0.44 to 1.18 mg kg^{-1} and in Shivar block it ranged from 0.30 to 1.08 mg kg^{-1}. Highest value of 1.18 mg kg^{-1} for available zinc was recorded in Western block and lowest value of 0.21 mg kg^{-1} also recorded in Gudadhi block. The availability of Zn becomes very low due to the high pH, $CaCO_3$ and high cropping intensity. This low content of DTPA-Zn in these soils might be due to fact that under alkaline conditions, the zinc cations are changed largely to their oxides or hydroxides and thereby lower the availability of zinc. The similar results were also reported by Meena *et al.* (2006) [9]. Available Fe content in soils of Gudadhi block ranged between 1.66 to 7.60 mg kg^{-1}, Western block soils ranged from 3.44 to 10.2 mg kg^{-1} and Shivar block ranged from 4.77 to 10.63 mg kg^{-1}. Considering critical limit for DTPA –Fe 2.5-4.5 mg kg^{-1} as given by Katyal and Rattan (2003) [7] these soils are found to be sufficient in available Fe content and it may be due to the increased in $CaCO_3$ and clay content in these soils. The high Fe content in soils may be due to presence of minerals like Feldspar, Magnetite, Hematite and Limonite which together constitute bulk of trap rock in these soils (Vijaya Kumar *et al.*2013) [12]. The available copper extracted by DTPA varied from 0.26 to 3.20 mg kg^{-1} for Gudadhi block, for Western block it ranged between 0.41 to 3.18 mg kg^{-1} and for Shivar block it ranged from 0.42 to 4.26 mg kg^{-1}. The highest value of 4.26 mg kg^{-1} was recorded in Western block and lowest value 0.26 mg $kg^{-1}$was recorded in Gudadhi block. The higher amount of DTPA-Cu in surface layer might be due to higher biological activities and chelating effect (Kadao *et al.*, 2002: Jibhkate *et al.*, 2009) [4, 3]. Considering critical limits of 0.2 mg kg^{-1} as suggested by Katyal and Rattan (2003) [7], these soils are categorised as high in available copper content. Magnitude of available manganese content in soils ranged from 1.5 to 8.73 mg kg^{-1} for Gudadhi block, for Western block it ranged from 1.89 to 9.39 mg kg^{-1} and in Shivar block it ranged from 3.07 to 7.67 mg kg^{-1} (Table no.3). The relative high content of Mn in these soils could be due to the soils derived from basaltic parent material which contained higher ferro magnesium minerals. Similar results were reported by Hundal *et al.* (2006) [1]. In the soils of Western part of CRS farm the availability of a copper decreased with increase in EC and availability of manganese increased with EC. Available zinc increased with potassium and decreased with available P.

Table 3: Micronutrient status of Western part of CRS Dr. PDKV Akola

Block	No. of samples analysed	parameters	Range (mg kg^{-1})	Mean (mg kg^{-1})	Ratings				
					VL	L	M	MH	H
Gudadhi	35	Zn	0.21-1.00	0.53	1 (2.9%)	21 (60%)	13 (37.1%)	0	0
		Fe	1.6-7.6	4.74	1 (2.8%)	10 (28.6%)	2 (5.7%)	0	22 (62.8%)
		Cu	0.26-3.20	1.81	0	0	0	35 (100%)	0
		Mn	1.5-8.73	4.50	0	1 (2.8%)	17 (48.6%)	17 (48.6%)	0
Western	20	Zn	0.44-1.18	0.75	0	3 (15%)	18 (85%)	0	0
		Fe	3.4-10.2	6.57	0	0	1 (5%)	8 (40%)	11 (55%)
		Cu	0.41-3.18	2.09	0	0	1 (5%)	1 (5%)	18 (90%)
		Mn	1.89-9.39	5.02	0	0	10 (50%)	8 (40%)	2 (10%)
Shivar	18	Zn	0.30-1.08	0.69	0	6 (33%)	12 (67%)	0	0
		Fe	4.7-10.6	7.11	0	0	2 (11%)	16 (89%)	0
		Cu	0.42-4.26	2.28	0	0	1 (5.5%)	1 (5.5%)	16 (89%)
		Mn	3.07-7.67	5.56	0	0	15 (83.3%)	3 (16.7%)	0



Categorisation of available zinc



Categorisation of available copper

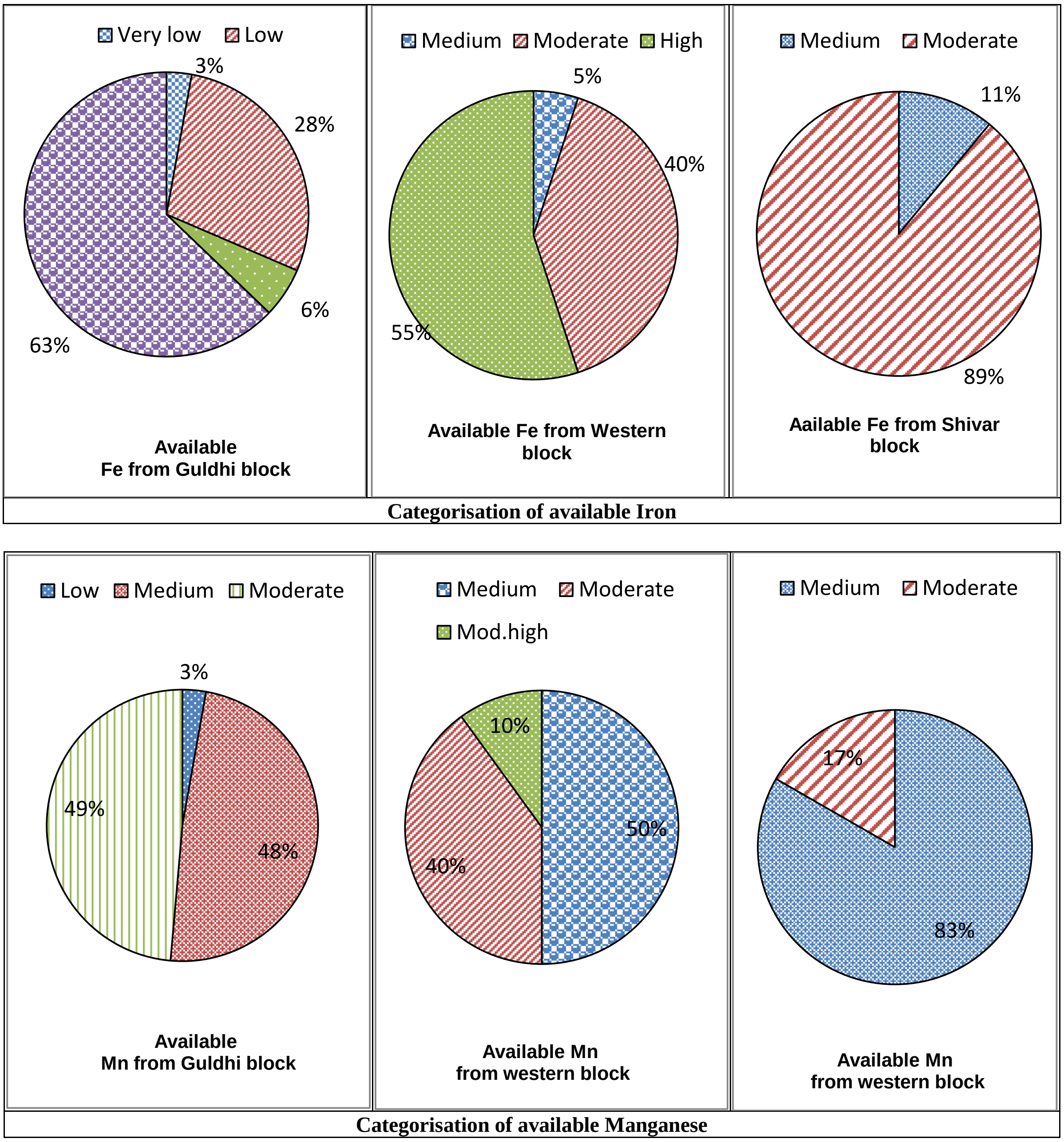


Fig 2: Micronutrient status of Western part of the Central Research Station Dr. PDKV Akola

Soil Nutrient Index Value

As per the NIV developed by the Ramamoorthy and Bajaj (1969) [10] the nutrient index value for soils(Table 4) of western part of the Central Research Station Dr. PDKV Akola represents fertility status for micronutrients. Fertility index for Gudadhi block, Western block and Shivar block were prepared by categorizing them into various categories as per six tier system by considering the average value of surface soils of blocks. The soils of Gudadhi, Western and Shivar blocks showed Medium to low NIV for available Zn *i.e.* 1.74, 1.7 and 1.44 respectively. These soils were in category of high NIV for available Fe, Cu, Mn (Table 4).

Table 4: Nutrient index value of Western part of CRS, Dr. PDKV Akola

Blocks	Elements	No. of samples analysed	Range	Mean	NIV	Category
Gudadhi	Avail. Zn (mg kg^{-1})	35	0.2-1.07	0.56	1.74	Medium
	Avail. Cu (mg kg^{-1})		0.26-3.20	1.81	3	High
	Avail. Fe (mg kg^{-1})		1.66-7.6	4.74	2.6	High
	Avail. Mn (mg kg^{-1})		1.5-8.73	4.50	2.9	High
Western	Avail. Zn (mg kg^{-1})	20	0.43-1.18	0.73	1.7	Medium
	Avail. Cu (mg kg^{-1})		0.41-3.18	2.09	3	High
	Avail. Fe (mg kg^{-1})		3.44-10.2	6.57	2.9	High
	Avail. Mn (mg kg^{-1})		1.89-9.39	5.02	3	High
Shivar	Avail. Zn (mg kg^{-1})	18	0.3-1.08	0.67	1.44	Low
	Avail. Cu (mg kg^{-1})		0.42-4.26	2.28	3	High
	Avail. Fe (mg kg^{-1})		4.77-10.63	7.11	3	High
	Avail. Mn (mg kg^{-1})		3.07-7.67	5.56	3	High

Correlation study

The overall correlation studies between physico-chemical properties and available macro and micronutrients in Gudadhi, Western and Shivar blocks were analyzed and presented in table 3.

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

	pH	EC	OC	$CaCO_3$	Zn	Cu	Fe	Mn
pH	1							
EC	-0.181	1						
OC	0.17	-0.232	1					
$CaCO_3$	0.013	0.037	0.202	1				
Zn	-0.252	-0.306	0.041	-0.179	1			
Cu	0.114	-0.348*	0.045	0.037	0.369*	1		
Fe	0.032	0.002	-0.283	-0.14	0.028	0.026	1	
Mn	0.02	0.024	-0.277	-0.209	-0.17	-0.071	-0.185	1

The EC of Gudadhi block soils showed significant and negative correlation with DTPA-Cu which is evident by 'r' value -0.348* and there was a positive correlation between DTPA-Fe and DTPA-Mn (Table 5). The higher amount of DTPA-Cu in surface layer might be due to higher biological activities and chelating effect (Kadao *et al*. 2002; Jibhakate *et al*. 2009) [5, 3].

Table 6: Correlation between the Physico-chemical properties and available nutrients in Western block of Western part of the CRS Dr. PDKV Akola

	pH	EC	OC	$CaCO_3$	Zn	Cu	Fe	Mn
pH	1							
EC	-0.298	1						
OC	0.069	-0.153	1					
$CaCO_3$	-0.12	0.045	-0.088	1				
Zn	0.097	-0.138	0.18	-0.448*	1			
Cu	0.169	0.03	-0.011	0.239	0.173	1		
Fe	0.089	-0.028	0.006	-0.131	0.216	0.036	1	
Mn	-0.292	0.479*	-0.133	0.186	-0.02	0.181	-0.028	1

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

The DTPA extractable zinc showed negative and significant correlation with calcium carbonate (r=-0.448*) and availability of Mn showed positive and significant relation with EC (r=0.479*) of the soil (Table 6). Similar results were observed by Katkar *et al.* (2013) [6]. Negative correlation of available Zn with CaCO3 may be attributed to their precipitation as hydroxides and carbonates consequently making them immobile and unavailable to the plants. Similar results were obtained by Shinde (2007) [11]

Table 7: Correlation between the Physico-chemical properties and available nutrients in Shivar block of Western part of the CRS, Dr. PDKV Akola

	pH	EC	OC	$CaCO_3$	Zn	Cu	Fe	Mn
pH	1							
EC	0.388	1						
OC	-0.038	-0.276	1					
$CaCO_3$	0.167	-0.136	0.298	1				
Zn	-0.298	-0.286	0.349	0.433	1			
Cu	-0.292	-0.479*	0.082	0.138	0.258	1		
Fe	-0.376	-0.009	0.025	0.12	0.359	-0.169	1	
Mn	-0.103	-0.03	-0.084	-0.293	-0.149	0.2	0.184	1

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

The significant negative correlation was observed in DTPA-Cu with EC (r=-0.479). Remaining properties does not show any relationship. Relationship among the physico-chemical and available nutrients varied and it might due to the different cropping system in western part of the CRS, Dr. PDKV, Akola.

Conclusion

The soils of western part of the central Research Station Dr. PDKV Akola are slightly alkaline to alkaline in nature, safe in electrical conductivity, medium to high in organic carbon and moderately calcareous to calcareous in nature. According to the concept of soil nutrient index soils are medium in DTPA-Zn while sufficient in DTPA-Fe, Cu and Mn content.

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