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Mapping of soil micronutrient status based on GPS- GIS and biological properties of Ajang village of Dhule tehsil of Dhule district Mharashtra

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Abstract
Present soil survey in Ajang village of Dhule tehsil of Dhule district (Maharashtra.) India was carried out during 2017 by using Global Positioning System (GPS) and Geographical Information System (GIS). Study was conducted to know the status of Fe, Mn, Zn, Cu, B and Mo and their relationship with soil properties. Total 129 surface soil samples were collected and analyzed to evaluate fertility status of soil and developed maps of Ajang village on the basis of nutrient status by using GIS. The results revealed that the study area soils were slightly too moderately alkaline in reaction and non-saline in nature. The organic carbon and calcium carbonate ranged from 0.75 to 6.00 g kg^{-1} and 0.63-10 per cent, repectively. The soils were very low to moderate in organic carbon and low too high in calcium carbonate content. The available micronutrients Fe, Mn, Zn, Cu, B and Mo ranged from 1.56 to 6.54, 2.01 to5.32, 0.31 to 1.76, 0.78 to 3.94, 0.26 to 0.68 and 0.068 to 0.372 mg kg^{-1} with mean of 4.35, 3.42, 0.65, 2.18, 0.50 and 0.157 mg kg^{-1}, respectively. The soils of Ajang village were deficient in available iron (41.08%), available zinc (42.64%) and available boron (43.41%). The available Fe and Zn showed negative significant correlation with pH and positive significant correlation with molybdenum. Available B showed positive significant correlation with organic carbon. Available Fe and B showed negative significant correlation with calcium carbonate content.

Keywords: Micronutrients, biological properties, GPS-GIS, soil survey

Introduction
Overexploitation of productive lands with increasing population pressure creates serious problem of lowering the fertility status of soil and it leads to deterioration of soil. The deficiency of nutrients directly effects on the growth of crops and crop response become poor. Hence, it is necessary to assess the fertility status of soil with the consideration of available nutrients in soils and to recommend the specific nutrients for the proper management of soil. Information on soil fertility status in crop field is very important and useful for fertilizer requirement and also to the specific management of the crop and soil. Micronutrients are important for maintaining the soil health and also increasing productivity of crops. The deficiency or the excess presence of the macronutrients may produce synergetic and antagonistic effects in plants. This caused declined in productivity of crops. The Global Positioning System (GPS) and Geographical Information System (GIS) are advanced tool in agriculture for future monitoring of soil nutrient status of different locations/villages. This technique is also useful for fulfilling the demand and supply of food commodities by judging the fertility status of different soils of study area. The data can be utilized for maintaining and building the fertility status of soils by balanced use of organic and inorganic fertilizers (Sood *et al.*, 2004) [21]. The site specific nutrient management can be judged by adopting this technique. Micronutrients (Fe, Mn, Zn, Cu B and Mo) along with soil microbial populations are important soil elements that are known to affect plant fitness and soil quality. Present study was undertaken to assess the available micronutrients status of Ajang village using Global Positioning System (GPS) and to develop maps of Ajang village on the basis of micronutrient status by using Geographical Information System (GIS).

Material and methods
The study area (Ajang village) is located between $20^0$52’52.28” to $20^0$88’11.88” N latitude and $74^0$53’24.39” to $74^0$89’01.08” E longitude covering an area of 1478.86 ha. Agro-climatically Ajang comes under Scarcity Zone No. VI. Geo-referenced surface (0-22.5 cm) soil samples were collected from Ajang village by using systematic sampling methodology based on GPS.

Total 129 soil samples were collected. The soil samples were processed and analyzed for their micronutrients status by standard analytical methods. Soil reaction was determined in 1:2.5 suspension using standard pH meter by potentiometry (Jackson, 1973) [11]. The electrical conductivity was determined by 1:2.5 suspension using EC meter by Conductometry (Jackson, 1973) [11]. Soil organic carbon was estimated using wet oxidation method (Nelson and Sommer, 1982) [17] and $CaCO_3$ is determined by acid neutralization method by (Alison and Moodie 1965) [1]. The DTPA extractable Mn, Fe, Cu and Zn were estimated by using Atomic Absorption Spectrophotometer method (Lindsay and Norvell, 1978) [13]. Available B was estimated by Azomethine-H method (Bingham, 1973) [2] and available Mo by AB-DTPA method (Soltanpour and Schwab, 1977) [20]. The fertility maps were developed by using Arc-GIS software 10.1 version. The fresh soil samples were used to estimate the microbial population (fungi, actinomycetes and bacteria) by serial dilution plate technique (Dhingra and Sinclair, 1993) [7] and dehydrogenase enzyme activity by spectrophotometric method (Casida *et al.*, 1964) [3].

Results and discussion

The results (Table 1) revealed that soil pH of Ajang village ranged from 7.1 to 8.3 with an average of 7.78. Most of the soil samples were slightly alkaline in soil reaction (Fig. 1). The pH is higher due to increase in accumulation of exchangeable sodium and calcium carbonate. In semi-arid regions, since rainfall is less as compared to annual evapo-transpiration, less chance is there for the leaching of insoluble carbonates and bicarbonates of the calcium. Similar results were reported by Shirgave and Ramteke (2015) [19]. The EC of soils of Ajang village ranged from 0.16 to 0.78dSm^{-1} with the mean value 0.40 dSm^{-1} (Table 1). The EC of soils under investigation fall under normal category (Fig. 2). Similar findings were reported by Vaddepally *et al.* (2017). It may be due to formation of these soils from basaltic parent material rich in basic cations. The organic carbon content in soils of Ajang village ranged from 0.75 to 6.00 g kg^{-1} the mean value 3.59 g kg^{-1} (Table 1). The soil samples were verylow to moderate category in organic carbon content (Fig. 3).

Table 1: Soil properties of Ajang village

Sr. No.	Parameter	Range	Mean
1	pH	7.1-8.3	7.78
2	Electrical conductivity (dSm^{-1})	0.16-0.78	0.40
3	Organic carbon (g kg^{-1})	0.75-6.00	3.59
4	Calcium carbonate (%)	0.63-10.00	3.89

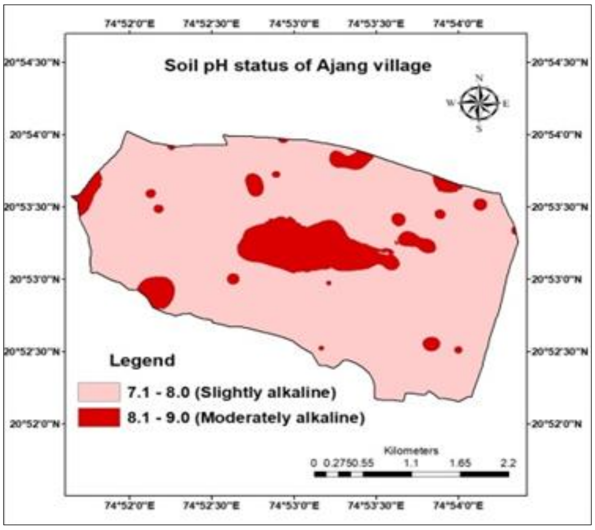

Fig 1: pH status of Ajang village

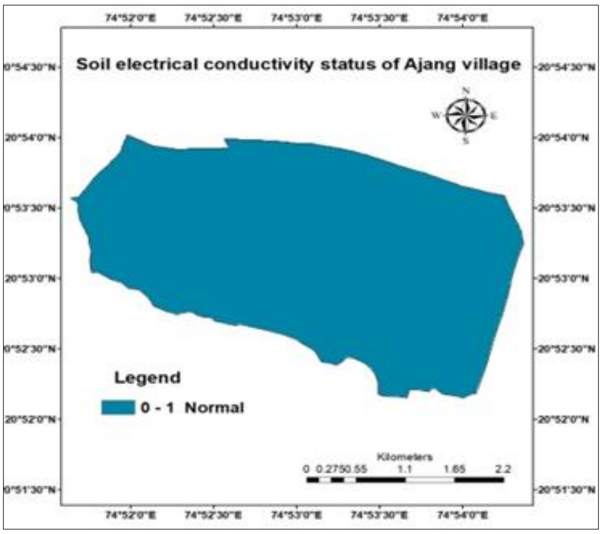

Fig 2: Electrical conductivity (dSm^{-1}) in soils of Ajang village

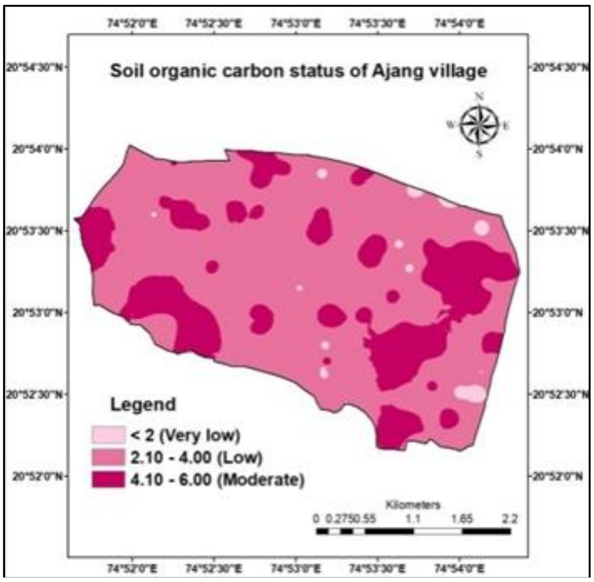

Fig 3: Organic carbon (g kg^{-1}) in soils Ajang village

The moderate organic carbon content might be due to high temperature prevailing during the summer under the semi-arid climate of Ajang village which favors for high rate of decomposition of organic matter also, removal of surface soil containing high organic carbon due to erosion was responsible for the lower OC. The similar trend was reported by Gosavi and Chaudhari (2016) [10]. The range of $CaCO_3$ in soils 0.63 to 10.00 per cent with an average of 3.89 per cent (Table 1). The soils of the Ajang village were low to high calcareous in nature (Fig. 4) soils from the area are formed from basaltic rocks under semi-arid climatic condition, characterized by low precipitation and high rate of evaporation favoring more accumulation and precipitation of $CaCO_3$. The similar results were found by Nalawade and Palwe (2014) [15].

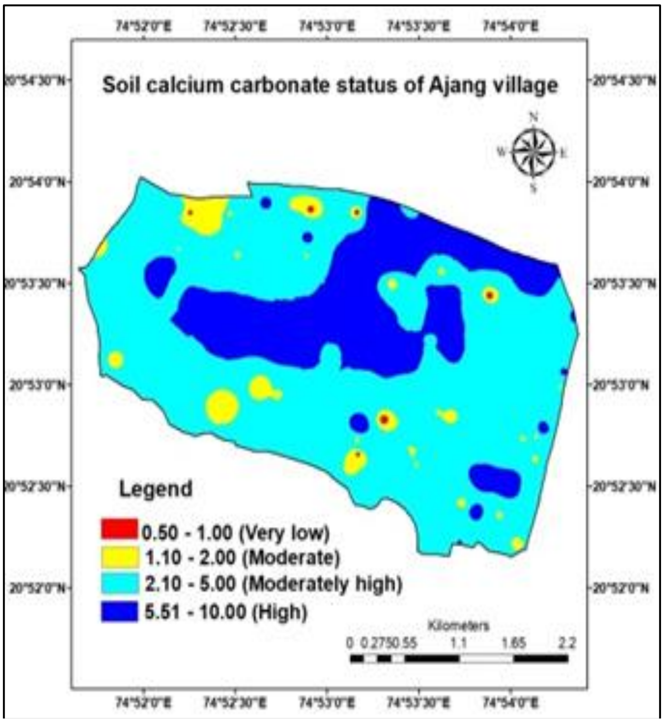

Fig 4: Calcium carbonate (%) in soils of Ajang village

The available iron in soils of Ajang village (M.S.) was ranged from 1.56 to 6.54mg kg^{-1} with an average of 4.35mg kg^{-1} (Table 2). The available iron in soils of Ajang village was under very low to moderate category (Fig 5). Out of all the 129 samples, 41.08 per cent samples were deficient and 58.92 per cent were sufficient in available iron. The majority of soils of this region were sufficient in Fe, this might be due to adequate quantity of organic matter content and in some content due to lack of moisture. The deficiency in some area might be due to excess of pH in soil. Similar result were reported by Mandavgade *et al.* (2015) [15] in soils from Jintur, Selu and Pathri tehsil of Parbhani district. The available manganese in soils of Ajang village varied from 2.10 to 5.32 mg kg^{-1} with mean value 3.42 mg kg^{-1} (Table 2). Available manganese was from moderate to moderately high category in soils of Ajang village (Fig. 6). All the samples were sufficient in available manganese. The sufficiency of available manganese might be due to high organic matter content under optimum soil reaction. Also the sufficient content of NPK is responsible for availability of manganese in soil. Gosavi and Chaudhari (2016) [10] in soils of Shirpur tehsil of Dhule district, Maharashtra. The available zinc in soils of Ajang village ranged from 0.31 to 1.76 mg kg^{-1} with an average of 0.65 mg kg^{-1} (Table 2). The available zinc in soils of

Table 2: Available micronutrient (mg kg^{-1}) status in soils of Ajang village

S. No.	Available micronutrient	Critical limit	Range	Mean	Sufficient (%)	Deficient (%)
1	Iron	4.5	1.56-6.54	4.35	58.92	41.08
2	Manganese	2.0	2.01-5.32	3.42	100	Nil
3	Zinc	0.6	0.31-1.76	0.65	57.36	42.64
4	Copper	0.2	0.78-3.94	2.18	100	Nil
5	Boron	0.5	0.26-0.68	0.50	56.59	43.41
6	Molybdenum	0.05	0.068-0.372	0.157	100	Nil

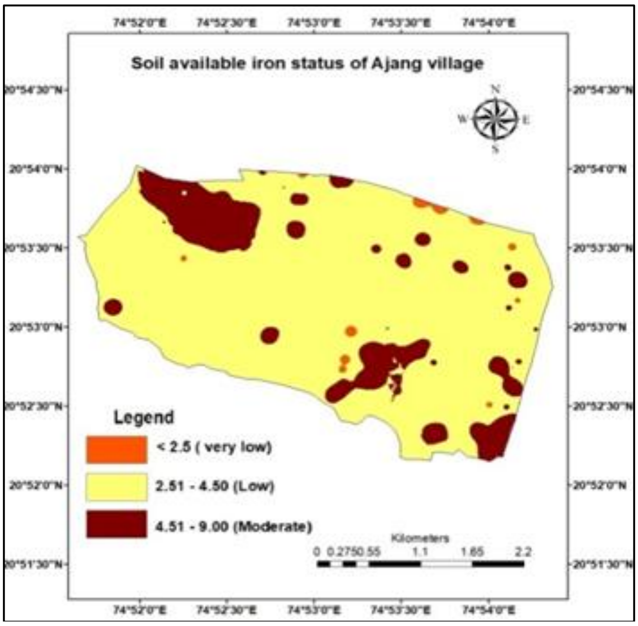

Fig 5: Available iron (mg kg^{-1}) in soils of Ajang village

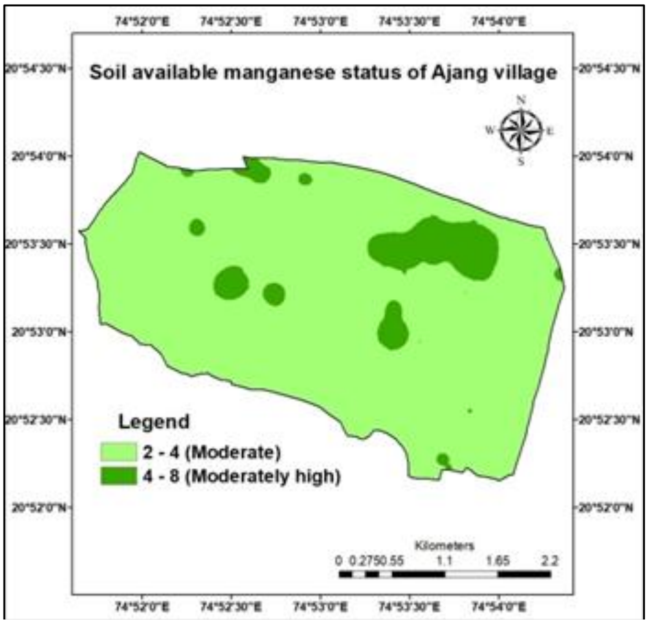

Fig 6: Available manganese (mg kg^{-1}) in soils of Ajang village

Ajang village was under low to moderately high category (Fig 7). The results showed that the 42.64 per cent samples were deficient and 57.36 per cent were sufficient in available zinc. The similar results were reported by Patil *et al*. (2016) [18] in soils of Agriculture College Farm. The deficiency in available Zn might be due to alkaline soil reaction. The sufficiency of Zn was due to moderate to high OC and optimum pH. Available copper in soils of Ajang village ranged between 0.78 to 3.94mg kg^{-1} with average value of 2.18 mg kg^{-1} (Table 2). The soil samples were fall under moderatetly high to very high in copper content (Fig. 8). The data indicated that all the samples were sufficient in available copper. Similar results were observed by Gore *et al*. (2017) [18] in soils of Wardha district of Maharashtra. The sufficiency of available copper in soils of Ajang village might be due to interactive effect of soil properties like pH, EC and OC which have managing role in availability of Cu.

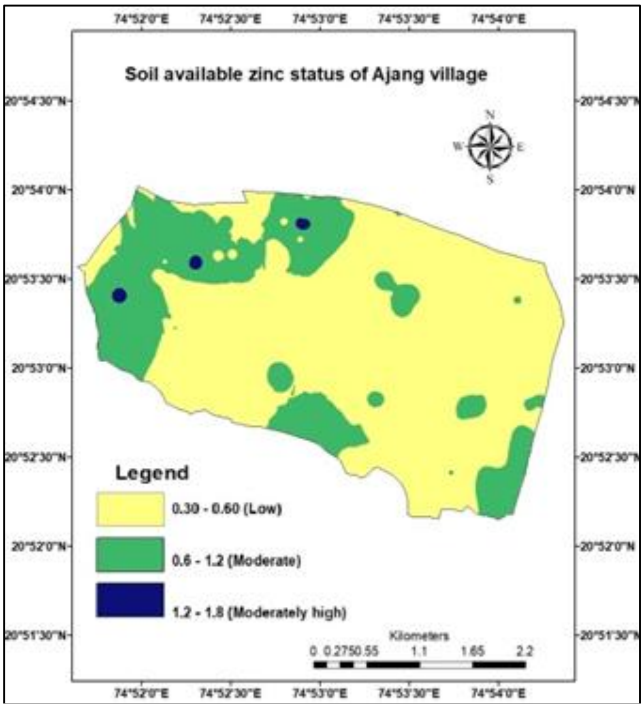

Fig 7: Available zinc (mg kg^{-1}) in soils of Ajang village

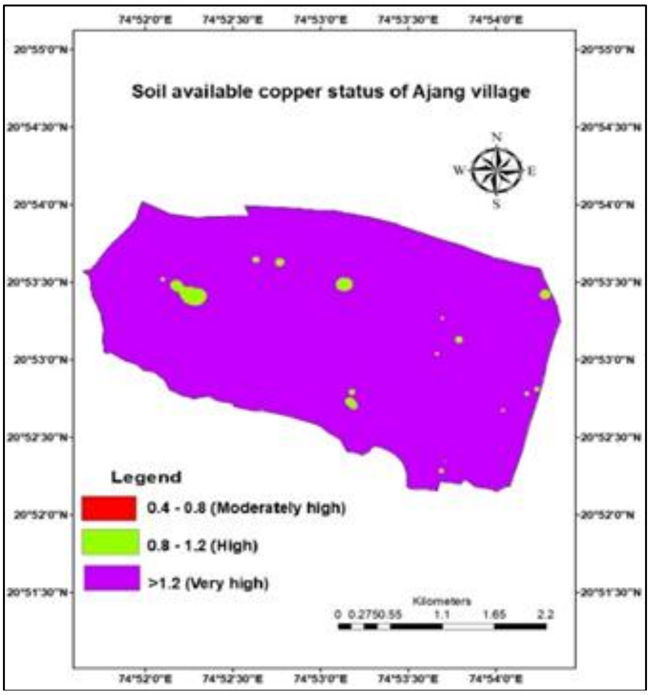

Fig 8: Available copper (mg kg^{-1}) in soils of Ajang village

The available boron in soils ranged from 0.26 to 0.68 mg kg^{-1} with an average of 0.50 mg kg^{-1} (Table 2). The available boron is categorized as low to moderate in soils of Ajang village (Fig. 9). Out of all the soil samples collected, 43.41 per cent samples were deficient and 56.59 were sufficient in available boron. The data indicate that the majority of soils found sufficient in available boron might be due to increased level of soil organic matter and slight deficiency might be due to unavailability of boron in alkaline pH of soil. Similar results were recorded by Singh *et al.* (2017) in soils of chandel district of Manipur. Available molybdenum in soils of Ajang village varied from 0.068 to 0.372 mg kg^{-1} with mean value 0.157 mg kg^{-1} (Table 2). The soils are under low to moderately high category of available molybdenum (Fig. 10). All the soil samples collected from Ajang village are sufficient in available molybdenum. The sufficiency of molybdenum might be due to higher amount of bases like Ca and Mg and alkaline pH at observed sites. This is because of increase in Mo availability with increase in pH due to replacement of MoO_4^{2-} by OH^- ions and moderate to high OC. The results of present investigation are in close proximity with the findings of Kondvilkar and Thakare *(*2015) in soils of Sakri tehsil of dhule district.

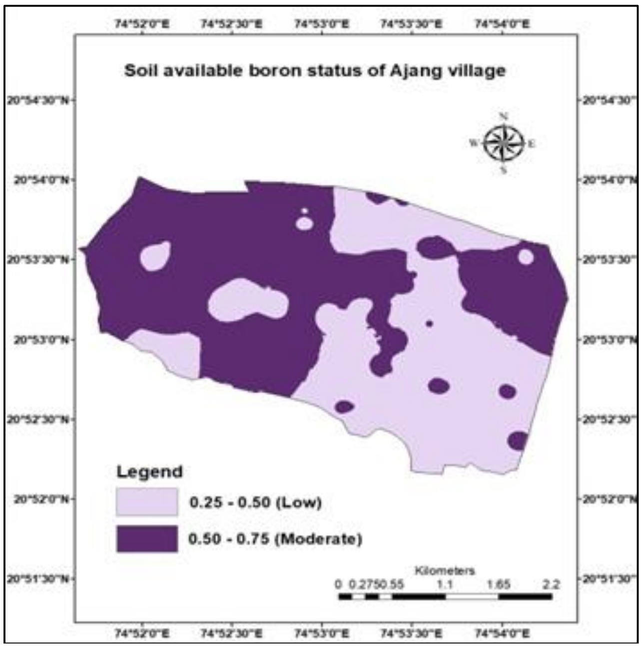

Fig 9: Available boron (mg kg^{-1}) in soils of Ajang village

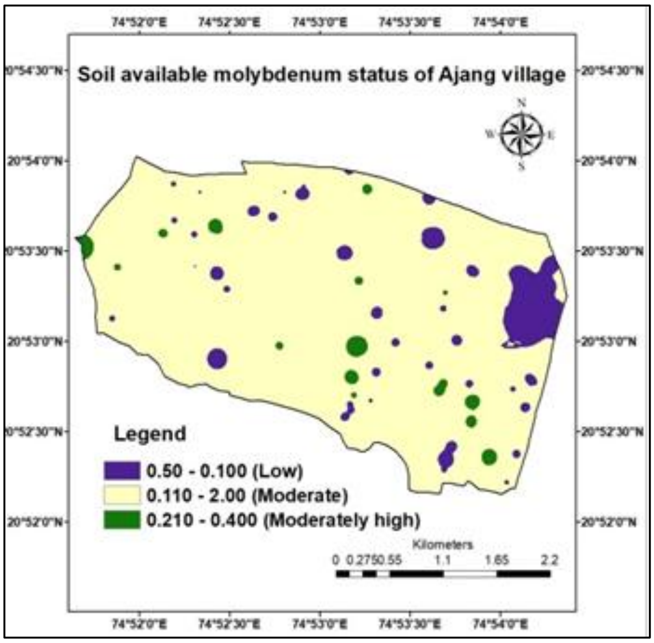

Fig 10: Available molybdenum (mg kg^{-1}) in soils of Ajang village

The microbial count of fungi in soils varied from 5 to 25×10^4cfu g^{-1} soil with an average of 14.96×10^4cfu g^{-1} soil

(Table 3). This data was closely confirmative with the recent result reported by Chaudhari *et al.* (2017) [6] in the soils of Dalwel village of Jalgaon District. The bacterial population in soil varied from to 10 to 52 $\times 10^7$cfu g^{-1} soil with an average of 32.55$\times$ 10^7cfu g^{-1} soil (Table 3). This data was closely confirmative with the results reported by Chang *et al.* (2007) [4] who stated that the bacterial population increased significantly in compost treated soils compared to controlled fertilizer treated soils. Also, recent study conducted by Chavan (2016) [6] at College of Agriculture, Dhule showed bacterial population were in relevant range. The microbial count of actinomycetes in soils varied from 15 to 60 $\times$ 10^6 cfu g^{-1} soil with an average of 34.93 $\times$ 10^6 cfu g^{-1} soil (Table 3). This data was closely confirmative with the results reported by Nakhro and Dhakar (2010) [16] who stated that the actinomycetes population increased due to addition of organic amendments that might have large impact on size and activity of actinomycetes population. Guleria and Chaudhari. (2017) [5] was recorded similar range of actinomycetes population in soils of Karanji village of Jalgaon District. The enzymatic activity in soils varied from 7.5 µg

Table 3: Soil microbial population and dehydrogenase activity in soils of Ajang village

Particulars	Soil microbial population			Dehydrogenase activity (µgTPF g^{-1} soil 24 hr^{-1})
	Fungi population ($\times 10^4$cfu g^{-1} soil)	Bacterial population ($\times 10^7$cfu g^{-1} soil)	Actinomycetes population ($\times 10^6$cfu g^{-1} soil)	
Mean	14.96	32.55	34.93	19.92
Range	5-25	10-52	15-60	7.5-35

TPF g^{-1} soil 24 hr^{-1} to 35 µg TPF g^{-1} soil 24hr^{-1} with an average of 19.92 µg TPF g^{-1} soil 24 hr^{-1} (Table 3). This data was closely confirmative with the recent study reported by Velmourougane *et al.* (2013) [23] who stated that the dehydrogenase activity was found to decline with depth and the maximum activity was recorded within 0-30 cm soil depth. The highest DHA was recorded in sub-humid moist bio climate followed by semi-arid dry and least in arid bio climate. Also, high management practices were found to increase the DHA compared to low management practices. Similar trend also reported by Guleria and Chaudhari (2017) [10] in soils of Karanji village of Jalgaon district. In the correlation study (Table 4), the negative significant correlation of soil pH Fe (-0.381**) and Zn (-0.281**) was observed. pH was positive and significantly correlated with Mo. The EC was negatively and non-significantly correlated with available Fe, Mn, Zn and Cu. while, it was positively and non-significantly correlated with available B and Mo. Organic carbon showed significant positive correlation with available B and non-significantly negatively correlated with Fe and Cu while, non-significantly and positively correlated with available Mn, Zn and Mo. Calcium carbonate was significantly negatively correlated with available Fe and B. Calcium carbonate showed non-significant negative correlation with available Zn and Cu and positive non-significant correlation with Mn and Mo.

Table 4: Correlation of available micronutrients with soil properties

Available micronutrient	Chemical properties			
	pH	EC	O.C.	$CaCO_3$
Fe	-0.381**	-0.046	-0.046	-0.251**
Mn	-0.023	-0.002	0.089	0.080
Zn	-0.281**	-0.101	0.132	-0.112
Cu	-0.087	-0.116	-0.060	-0.098
B	-0.059	0.058	0.268**	-0.456**
Mo	0.380**	0.083	0.059	0.054

(Number of samples- 129, *significant at 5% and **Significant at 1%)

Conclusion

The area of Ajang village was slightly alkaline to moderately alkaline in soil reaction and normal in salt content. The soils were low to moderate in organic carbon and low to high in calcium carbonate content. In case of micronutrients, 41.08 per cent samples were deficient and 58.92 per cent samples were sufficient in available iron. Total 42.64 per cent soil samples were deficient and 57.36 per cent soil samples were sufficient in available zinc. The available boron, 43.41 per cent samples showed deficiency and 56.59 per cent samples were sufficient. Similarly the soils of Ajang village were sufficient in available Mn, Cu and Mo. The soil microbial count of Ajang village for fungi, bacteria and actinomycetes ranged from 5 to 25$\times 10^4$cfu g^{-1} soil, 10 to 52$\times 10^7$cfu g^{-1} soil and 15 to 60$\times 10^6$cfu g^{-1} soil**,** respectively whereas, range of dehydrogenase enzyme in soil was from 7.5 to 35 µg TPF g^{-1} soil 24 hr^{-1}. The soil fertility maps of Ajang village will be of great utility for monitoring the fertilization schedule on sound scientific footing for improving the crop yields of Ajang village. Moreover, the timely monitoring of soil health deterioration can also be maintained by following appropriate soil reclamation techniques.

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