MACRONUTRIENT AND BIOLOGICAL STATUS IN SOILS OF KARANJI VILLAGE OF PAROLA TEHSIL OF JALGAON DISTRICT (M.S.), INDIA

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Abstract: *Soil survey was carried out during 2016 in Karanji village of Parola tehsil of Jalgaon district (M.S.), India by using Global Positioning System (GPS) and Geographical Information System (GIS). Soil samples were analyzed for pH, EC, OC, $CaCO_3$ and available macronutrients viz., available N, P, K, exchangeable Ca^{+2}, exchangeable Mg^{+2} and available S. The availability of macronutrients, micronutrients and their relationship with soil properties were also studied. The soil pH varied from 7.2 to 8.4 with mean value of 7.92 and indicated that slightly to moderately alkaline in reaction. The soil EC varied from 0.12-0.41 dSm^{-1} (mean 0.25 dSm^{-1}) and indicated that 100 per cent soils were non saline in nature. The organic carbon and calcium carbonate ranged from 2.87-8.90 g kg^{-1} and 1.5-11.0% with mean value of 6.47 g kg^{-1} and 5.10 %, respectively. The soils of Karanji village were low to high in organic carbon and moderate to very high in calcium carbonate content. The available macronutrients N, P, K, exchangeable Ca, exchangeable Mg and available S ranged from 112.89 to 288.51 kg ha^{-1}, 2.00 to 27.40 kg ha^{-1}, 164.24 to 687.68, 22.4 to 41.1 cmol (p^+) kg^{-1}, 11.2 to 26.0 cmol (p^+) kg^{-1} and 7.48 to 29.97 mg kg^{-1} with mean of 191.71 kg ha^{-1}, 12.42 kg ha^{-1}, 425.65 kg ha^{-1}, 29.29 cmol (p^+) kg^{-1}, 16.92 cmol (p^+) kg^{-1} and 18.65 mg kg^{-1}, respectively. The soils of Karanji village were deficient in available sulphur (5.38%) whereas, exchangeable Ca and Mg were 100% sufficient. The available P showed negative significant correlation with pH. Available N showed positive significant correlation with organic carbon.*

Key words: *Macronutrients, microbial count, dehydrogenase enzyme, Global Positioning System (GPS) and Geographical Information System (GIS).*

Introduction:

The Global Positioning System (GPS) and Geographic Information System (GIS) are advanced tool for studying on site specific nutrient management which can be efficiently use for monitoring soil fertilization in Karanji village of Parola tehsil of Jalgaon district (M.S.) and would be useful for ensuring balanced fertilization to crops. Investigation of nutrients status in soils mostly carried out to explain crop failures and to determine the effect on plant growth of elements, other than those already recognized as essential. Macronutrients are important for maintaining soil health and also increasing productivity of crops. The deficiency or the excess presence of the macronutrients such as N, P, K, exchangeable Ca & Mg and S may produce synergetic and antagonistic effects in plants. This caused declined in productivity of crops. Nutrients strength and their relationship with soil properties affect the soil health. The present study was taken up to assess the available macronutrients status of Karanji village for available N, P, K, exchangeable Ca & Mg and available S by using Global Positioning System (GPS) and to develop maps of Karanji village based on nutrient status by using Geographical Information System (GIS).

Material and methods:

The study area *i.e.* Karanji village covering an area of 341.77 ha. It lies between 20^0 88' 0" North latitude and 75^0 12' 0" East longitude. It belongs to Khandesh and Northern Maharashtra region. It is located 59 km towards west from district headquarters Jalgaon and 362 km from state capital, Mumbai. The climate of tehsil is whole dry except during south west monsoon season. Agro-climatically Karanji comes under Scarcity Zone No. VI. The processed soil samples were analyzed for the basic soil parameters *viz.,* pH, EC, OC, and $CaCO_3$, available macronutrients *viz.*, N, P, K, exchangeable Ca & Mg and S by using standard analytical methods. Also, soil microbial population (*i.e.* fungi, actinomycetes and bacteria) and dehydrogenase enzyme activity was quantified.

Results and discussion:

The range and mean values of analyzed soil samples are given in the Table 1, 2 and 3. The soil pH of Karanji village ranged from 7.20 to 8.40 with an average of 7.92 (Table 1). Most of the soil samples were slightly alkaline in soil reaction (Fig. 1). Similar results were reported by Kadu (2007). 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. The EC of soils of Karanji village ranged from 0.12 to 0.41 dSm^{-1} with the mean value 0.25 dSm^{-1} (Table 1). The EC of soils under investigation fall under normal category (Fig. 2). Similar results were reported by Waikar *et al.* (2004). It may be due to formation of these soils from basaltic parent material rich in basic cations.

The organic carbon content in soils of Karanji village ranged from 2.87 to 8.90 g kg^{-1} the mean value 6.47 g kg^{-1} (Table 1). The soil samples were low to moderately high category in organic carbon content (Fig. 3). The similar findings were reported by Chaudhari and Kadu (2007). The moderate organic carbon content might be due to high temperature prevailing during the summer under the semi-arid climate of Karanji 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 range of $CaCO_3$ in soils 1.5 to 11.0 per cent with an average of 5.10 per cent (Table 1). The similar results were found by Dhage *et al.* (2000). The soils of the Karanji village were moderate to very highly 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 $CaCO_3$.

Table 1: Soil properties of Karanji village

Sr. No.	Parameter	Range	Mean
1	pH	7.2-8.4	7.92
2	Electrical conductivity (dSm^{-1})	0.12-0.41	0.25
3	Organic carbon (g kg^{-1})	2.87-8.90	6.47
4	Calcium carbonate (%)	1.5-11.0	5.10

The available nitrogen in soils of Karanji village (M.S.) was ranged from 112.89 to 288.51 kg ha^{-1} with an average of 191.71 kg ha^{-1} (Table 2). The available nitrogen in soils of Karanji village were under very low to moderate (Fig 5). Out of all the 93 samples, 5.38 per cent samples were in very low, 89.24 per cent in low and 5.38 per cent were in moderate available nitrogen. The available nitrogen content was low in major portion of the study area because of low to moderate organic matter content in these soils. The variation in N content may be related to soil management, application of organic manures and fertilizers to previous crop. The nitrogen content in the soils is dependent on temperature, rainfall and altitude. The similar trend of available N was reported by Kumar *et al.* (2015) in soils of Raipur district of Chhattisgarh. The available phosphorus in soils of Karanji village varied from 2.00 to 27.40 kg ha^{-1} with mean value 12.42 kg ha^{-1} (Table 2). Available phosphorus was from very low to moderately high category in soils of Karanji village (Fig. 6). About 13.98 per cent samples were in very low category whereas, 59.14 per cent in low, 21.50 per cent in moderate and 5.38 per cent in moderately high. Low status of available P in soils of studied area might be due to alkaline soil reaction and high content of $CaCO_3$ in the soil. The range is quite large which might be due to variation in soil properties *viz.,* pH, calcareousness, organic matter content, texture and various management and agronomic practices. At the higher pH calcium can precipitate with P as Ca-phosphate and reduce phosphorus availability. Similar results were also reported by Chaurasia *et al.* (2013) in the low level flood plains near Varuna river in Allahabad. The available potassium in soil was ranged from 164.24 to 687.68 kg ha^{-1} with an average of 425.65 kg ha^{-1}. Soil samples varied from moderate to very high category of available potassium (Fig. 7). Out of the total soil samples, 4.30 per cent were in moderate category, 3.22 per cent in moderately high, 9.68 per cent in high and 82.80 per cent in very high category. The similar trends of available potassium were reported by Padmavathi *et al.* (2014) in soils of Coimbatore district, Tamil Nadu, Kumar *et al.* (2015) in soils of Raipur district, Chhattisgarh and Shirgave and Ramteke (2015) in soils of Arjunnagar, Kohlapur district, Maharashtra. The high content of available K in the soil could be attributed due to the dissolution and diffusion of K from internal crystal lattice of silicate clay minerals under the condition of high clay content especially of montmorillonitic clay minerals present in soil (Durgude, 1999). The available potassium content in major portion of the study area was in high category. Black soils were higher in available K status than red soils which may due to predominance of K rich micaceous and feldspars minerals in parent material. Similar results were observed by Setia *et al.* (2012).

The exchangeable Ca in soils of Karanji village ranged from 22.4 to 44.1 [cmol (p^+) kg^{-1}] with an average of 29.29 [cmol (p^+) kg^{-1}] (Table 2). The results showed that 100 per cent samples were sufficient in exchangeable Ca (Fig. 8). The similar trend was also recorded by Kawde *et al.* (2005) in soils Keliveli, district Akola and Tripathi and Sawarkar (2007) from Vertisol pedons of Kymore plateau of Jabalpur district. The higher amount of exchangeable Ca^{++} content found in soils under study may be due to high clay content and calcareous nature. The sufficiency of exchangeable Ca^{++} is due to no leaching of bases and moderate to high organic carbon values. Calcium is greater in black soil than red soil. Calcium is attributed to the type and amount of clay present in soil. The exchangeable Mg in soils of Karanji village ranged between 11.2 to 26.0 cmol (p^+) kg^{-1} with average value of 16.87 cmol (p^+) kg^{-1} (Table 2). All the soil samples (100%) were in sufficient category (Fig. 9). The similar results were observed by Medhe *et al.* (2012) in soils of Chakur tehsil of Latur district, Maharashtra, Shinde and Phalke *et al.* (2014) in soils from Godavari basin of Jalna (India). All the soils were sufficient in Mg^{++} which may be due to its genesis in the semiarid area, less leaching because of low precipitation, moderate to high organic carbon and calcareousness of soil was responsible for availability of magnesium in soil. These types of soils have high CEC.

Table 2: Available macronutrient status in soils of Karanji village

Particulars	Soil available macronutrients					
	Nitrogen (kg ha^{-1})	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})	Calcium [cmol(p^+)kg^{-1}]	Magnesium [cmol(p^+)kg^{-1}]	Sulphur (mg kg^{-1})
Range	191.71	2.00-27.40	425.65	22.4-41.1	11.2-26.0	7.48-29.97
Mean	112.89-288.51	12.42	164.24-687.68	29.29	16.92	18.65
Critical limit	-	-	-	20	10	10
Sufficient	-	-	-	93	93	88
Deficient	-	-	-	-	-	5

The available sulphur in soils ranged from 7.48 to 29.97 mg kg^{-1} with an average of 18.65 mg kg^{-1} (Table 2). The available sulphur is categorized as very low to high in soils of Karanji village (Fig. 10). Out of the total soil samples 5.38 per cent soils were in deficient and 94.62 per cent were in sufficient range for available sulphur. Out of total 93 soil samples, 5 samples (5.38%) were found in low, 21 samples (22.58%) were found in moderate, 28 samples (30.11%) in moderately high and 39 samples (41.93%) were found in high category. The most of S in soil is in organic combination; therefore, soils which are rich in organic matter will have high level of S (Kanwar, 1976). The sufficiency of available sulphur is directly proportional to the organic matter content of the soil. The similar results were found by Jat and Yadav (2006) in soils of Entisols of Jaipur district, Rajasthan, Singh and Singh (2007) in soils of mid-Western Uttar Pradesh, Patel[a] *et al.* (2014) at different villages of Kutch district of Gujarat.

The microbial count of fungi in soils varied from 4 to 27×10^4 cfu g^{-1} soil with an average of 9.01 ×10^4 cfu g^{-1} soil (Table 3). This data was closely confirmative with the recent result reported by Narkho and Dhakar (2010) who stated that the fungi population increased due to addition of organic amendments that might have large impact on size and activity of fungal population. The bacterial population in soil varied from to 10 to 71 ×10^7 cfu g^{-1} soil with an average of 38.19× 10^7cfu g^{-1} soil (Table 3). This data was closely confirmative with the results reported by Chang *et al.* (2007) 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) at College of Agriculture, Dhule showed bacterial population were in relevant range. The microbial count of actinomycetes in soils varied from 10 to 92 × 10^6 cfu g^{-1} soil with an average of 53.37 × 10^6 cfu g^{-1} soil (Table 3). This data was closely confirmative with the results reported by Narkho and Dhakar (2010) 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. Also, Malhotra *et al.* (2015) recently reported that the actinomycetes population from the farmer's fields in tropical Vertisols of Peninsular India were seriously affected when "very high" application of fertilizer and 1.5 times pesticides were applied in the chilli fields (38.8±2.8 cfu g^{-1}) over normal rates (66.8±2.8 cfu g^{-1}).

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

Particulars	Soil microbial population			
	Fungi population (×10^4 cfu g^{-1} soil)	Bacterial population (×10^7 cfu g^{-1} soil)	Actinomycetes population (×10^6 cfu g^{-1} soil)	Dehydrogenase activity (µgTPF g^{-1} soil 24 hr^{-1})
Mean	9.01	38.19	53.37	14.05
Range	4 - 27	10 – 71	10 - 92	8 – 39

The enzymatic activity in soils varied from 8 µg TPF g^{-1} soil 24 hr^{-1} to 39 µg TPF g^{-1} soil 24hr^{-1} with an average of 14.05 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) 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 bioclimate followed by semi-arid dry and least in arid bioclimate. Also, high management practices were found to increase the DHA compared to low management practices.

Table 4: Correlation of available macronutrients with soil properties

Available micronutrient	Chemical properties			
	pH	EC	O.C.	$CaCO_3$
Nitrogen	-0.107	0.184	**0.454****	0.024
Phosphorus	**-0.830****	-0.100	-0.173	-0.200
Potassium	0.164	0.030	0.215*	-0.162

Calcium	0.103	-0.126	0.007	-0.062
Magnesium	0.031	-0.069	-0.032	0.054
Sulphur	-0.098	0.172	**0.652****	-0.003

(Number of samples- 93, *significant at 5% and **Significant at 1%)

Conclusion:

The area of Karanji village was slightly alkaline to moderately alkaline in soil reaction and normal in salt content. The soils were low to high in organic carbon and moderate to very high in calcium carbonate content. In case of macronutrients, 5.38 per cent soil samples were categorized as very low as well as moderate and 89.24 per cent samples in low category in available nitrogen. Whereas, 13.98 per cent in very low category whereas, 59.14 per cent in low, 21.50 per cent in moderate and 5.38 per cent in moderately high in available phosphorus. Out of the total soil samples, 4.30 per cent were in moderate category, 3.22 per cent in moderately high, 9.68 per cent in high and 82.80 per cent in very high category. Similarly the soils of Karanji village were sufficient in exchangeable Ca and Mg. Also, 5.38 per cent soils were in deficient and 94.62 per cent were in sufficient range for available sulphur. The soil microbial count of Karanji village for fungi, bacteria and actinomycetes ranged from 4 to 27×10^4 cfu g^{-1} soil, 10 to 71×10^7 cfu g^{-1} soil and 10 to 92×10^6 cfu g^{-1} soil**,** respectively whereas, range of dehydrogenase enzyme in soil was from 8 to 39 μg TPF g^{-1} soil 24 hr^{-1}.

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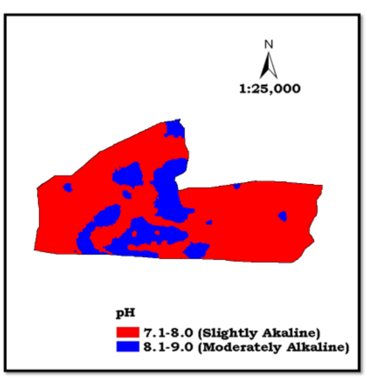

Fig. 1. pH status of Karanji village

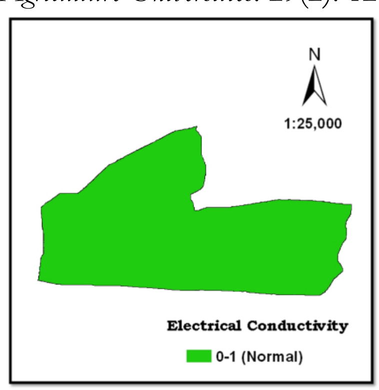

Fig. 2. Electrical conductivity (dSm^{-1}) in soils of Karanji village

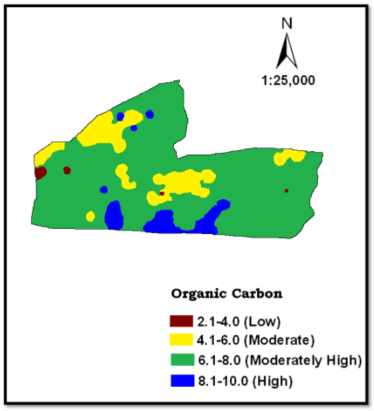

Fig. 3. Organic carbon (g kg^{-1}) in soils Karanji village

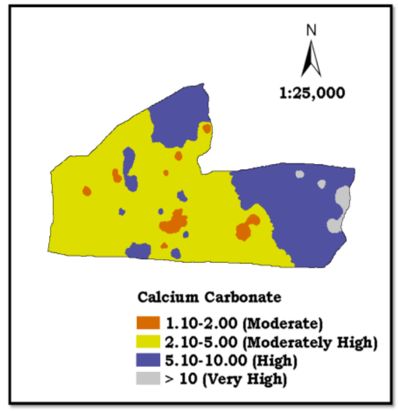

Fig. 4. Calcium carbonate (%) in soils of Karanji village

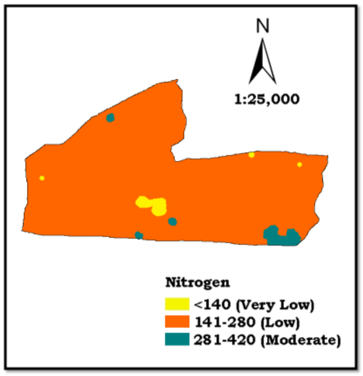

Fig. 5. Available nitrogen (kg ha^{-1}) in soils of Karanji village

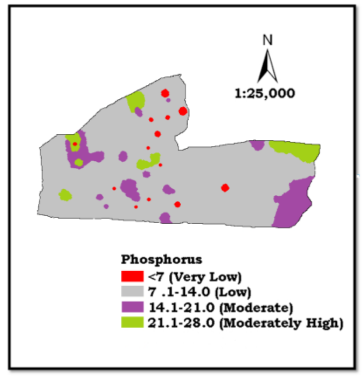

Fig. 6. Available phosphorus (kg ha^{-1}) in soils of Karanji village

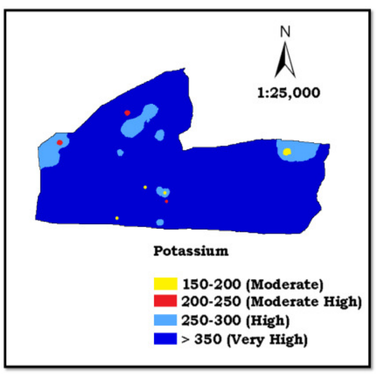

Fig. 7. Available potassium (kg ha^{-1}) in soils of Karanji village

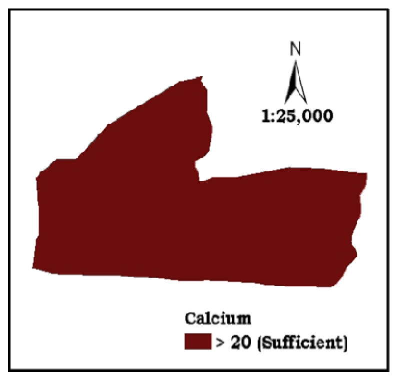

Fig. 8. Exchangeable calcium [cmol (p+) kg^{-1}] in soils of Karanji village

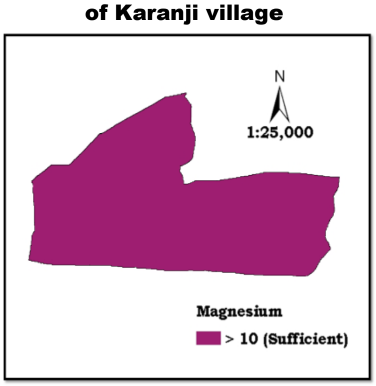

Fig. 9. Exchangeable calcium [cmol (p+) kg^{-1}] in soils of Karanji village

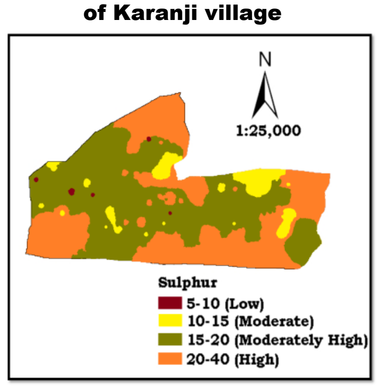

Fig. 10. Available sulphur (mg kg^{-1}) in soils of Karanji village