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Effect of NPK and other Micronutrient on Paddy Soil

RUPCHAND R. TIKALE[1]* and SWAPNIL V. MADHAMSHETIWAR[2]

[1]CHLR, Sardar Patel College, Chandrapur-442401, Maharashtra, India.
[2]Department of Chemistry, Sardar Patel College, Chandrapur-442401, Maharashtra, India.
*Corresponding authro E-mail: rupchandtikale@gmail.com, swapnshilp.chem@gmail.com

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ABSTRACT:

Soil quality is crucial for the fulfilment of food requirement of huge population of developing countries like India. The goal of the current investigation was to assess the impact of crop harvesting on soil with special reference to paddy crop. To meet the study's goals, fifteen locations were chosen from Mul tehsil in Chandrapur District (M.S.), India. The study used a systematic sampling and samples were chosen grid-wise based on how the population cluster used the rice that was grown. During the study, numerous markers connected with soil quality were inspected, including pH, electrical conductivity (EC), nitrogen, potassium, phosphorus, water holding (WH), zinc (Zn), copper (Cu), iron, and natural carbon (OC). The results obtained indicate that the soil of the study area was saline at more than 75% of the sampling sites. Greater soil fertility is found at more than 81% of the sites as indicated by OC values. The soil was observed from acidic to alkaline in nature. The soil's suitability for paddy crops is also indicated by the levels of iron, zinc, copper, and nitrogen. Most of the physical characteristics and micronutrient content dropped after the harvesting of rice crop except copper.

Keywords: Soil health, pH, OC, Crop, Soil fertility, NPK, Mul tehsil, Maharashtra.

INTRODUCTION

Asia's agricultural output needs to rise to feed its expanding population. To enhance the crop production, farmers are using inorganic fertilizers and other different practices which are disturbing the soil health. Excess use of inorganic fertilizer impacting the soil microflora which are very essential in maintaining the health of soil as they help in breakdown of organic material, nutrient recycling and biotransformation of pollutants[1,2]. Beside this, tillage practices, excess of irrigation, crop rotation, and crop mixing are some of the factors that affect the soil fertility[3,4].

Several environmental issues, including soil acidity and compaction, have been brought on by the misuse of chemical fertilizers in recent years. These issues can be resolved by switching to organic fertilizers from chemical ones[2,5]. Using a soil index to evaluate the fertility of the soil can offer important insights into practical approaches and future-proof methods for achieving sustainable paddy cultivation. By creating and maintaining soil fertility, soil fertility (SF) can be managed. Fertilization has become a widely used management strategy to boost crop yields as agricultural output has increased[5,6]. Long-term field experiments (LTFEs) offer measurements on the fertility and quality of the soil and can be used to predict the interactions between the environment and soil productivity. Many investigations into the impact of fertilizers on soil fertility were started in the past, across the world[7,8].

Among all agricultural products, rice crops require the greatest amount of water. Although an accurate evaluation of the extent of water shortage in Asian rice production is still lacking, there are signs that the rice-based agricultural system's sustainability is being threatened by diminishing water quality and decreased availability of water resources[9]. One of the key factors preventing rain-fed rice from yielding much is drought. Research on increasing rice yields while using less water is crucial for the food security and environmental well-being of Asia[9,10].

Many farmers in Mul Tehsil skillfully farmed crops including rice, wheat, legumes, etc. to achieve large yields. Their ignorance of the necessity of all necessary micronutrients being present for stable soil quality is the reason behind their erroneous use of many pesticides and inorganic fertilizers. Soil quality is lowered by reduced usage of organic fertilizer and increased input of mineral fertilizers, which results in reduced organic carbon in the soil[11]. Therefore, the present study was carried out to evaluate the characteristics of soil before and after the harvesting of paddy crop in Mul tehsil of Chandrapur district, Maharashtra, India. This is the first study of its kind conducted in Maharashtra's Mul tehsil.

MATERIALS AND METHODS

Study area

The study area is located at 20° 4' 19.4016'' N and 79° 40' 24.7368'' E (Table 1) in Mul, Maharashtra. This tehsil is nearby Shindewahi, Sawali, Pombhurna, and Chandrapur and We are studying a few communities in the Mul tehsil.

Sample preparation and analysis

The soil samples were prepared and analyzed following the standard methods which were used by several authors in their studies and they also recommended those for future studies[7,12]. The used methods are given in Table 2.

Table 1: Soil sampling with GPS mapping in Mul Tehsil of Maharashtra state in India

Sample Code	Village Name	Site Code	Latitude	Longitude
MH-MUL-01	Kosambi	SC-01	20.075454	79.658820
MH-MUL-02	Maroda	SC-02	20.102035	79.657680
MH-MUL-03	Katwan	SC-03	20.065854	79.622631
MH-MUL-04	Janala Ryt.	SC-04	20.026861	79.609384
MH-MUL-05	Tolewahi	SC-05	19.999142	79.602174
MH-MUL-06	Kantapeth Ryt.	SC-06	20.010974	79.613656
MH-MUL-07	Chiroli	SC-07	19.994528	79.624107
MH-MUL-08	Sushi Dabgaon	SC-08	19.956965	79.612806
MH-MUL-09	Pipari Dixit	SC-09	19.952963	79.663788
MH-MUL-10	Dugala	SC-10	19.953834	79.726131
MH-MUL-11	Sintala	SC-11	19.962001	79.698984
MH-MUL-12	Bhejgaon	SC-12	19.976751	79.690146
MH-MUL-13	Haldi Gaonganna	SC-13	19.992644	79.693887
MH-MUL-14	Chichala (Mo)	SC-14	20.009598	79.697732
MH-MUL-15	Rajoli	SC-15	20.193763	79.685675

(MH- Maharashtra, MUL- MUL Tehsil)

Table 2: Properties of Soil analyzed and standard method used during the study period

S. No	Parameters	Method used
1	Water Holding Capacity (%)	Gravity method
2	Electrical Conductivity (Ds/cm^3)	Using Conductivity meter
3	Total Organic Carbon (%)	Volumetric and colorimetric methods
4	pH	Using pH meter
5	P (Mg/Kg)	Colorimetric methods
6	NO_3-N (Mg/Kg)	Titration method
7	K (Mg/Kg)	Flame photometer
8	Cu (Mg/Kg)	Atomic Absorption Spectrometry (AAS) method
9	Zn (Mg/Kg)	Atomic Absorption Spectrometry (AAS) method
10	Fe (Mg/Kg)	Atomic Absorption Spectrometry (AAS) method

RESULTS AND DISCUSSION

Several soil quality parameters, including pH, electrical conductivity, water holding capacity, nitrogen, potassium, phosphorus, zinc, copper, iron, and organic carbon, were measured in soil samples. The outcomes attained over the research period are provided in Table 3.

Table 3: Showing the result of WHC, EC, pH, OC, N, P, K, Zn, Cu, Fe

Village code	Water Holding Capacity(%)		EC (Ds/cm^3)		pH		Organic Carbon(%)		Nitrogen (Kg ha^{-1})		Zinc (ppm)		Copper (Mg kg^{-1})		Iron%		Phosporus (Kg ha^{-1})		Potassium (Kg ha^{-1})	
	BH	AH	BH	AH	BH	AH	BH	AH	BH	AH	BH	AH	BH	AH	BH	AH	BH	AH	BH	AH
SC-01	27	25	0.5	0.4	4.5	3.9	1.9	1.8	310	309	21.8	21.5	4	5	22.8	21.7	22	19	271	269
SC-02	21.3	17.5	0.7	0.6	7.1	7.3	2.1	1.8	120	118	37	34	4.3	4.1	14	11	17.3	15.2	180	176
SC-03	21.5	18	0.8	0.5	8.5	8.3	1.9	0.6	127	124	65	34	7	6	11.7	10.5	21.31	18	164	163
SC-04	29.8	27	0.3	0.3	7.5	7.4	2.4	2.3	108	109	58	55	2.5	2.2	6.6	5.9	16.3	18.2	155	158
SC-05	13.8	12.5	0.2	0.3	4.9	4.6	0.8	0.6	289	285	63	61	4.5	4.4	11.2	9.6	15.49	14.23	159	157
SC-06	22.2	21.5	0.5	0.4	11.7	10.8	1.3	1.2	161	159	36	32	27.4	26.3	7.4	6.1	15.21	14.56	264	261
SC-07	18.5	17.2	0.6	0.4	10.8	10.1	3.2	3	121	118	61	62	1.8	1.6	5	4.8	21.69	23.78	258	256
SC-08	23	21	0.9	0.8	8.5	8.2	2.9	2.7	79	82	34	32	2.1	1.9	4.7	4.1	14.87	14.12	188	184
SC-09	22.3	21.5	0.5	0.3	8.9	8.6	0.8	0.7	124	121	58	56	18.3	16.2	6.8	6.4	23.6	21.58	210	213
SC-10	22.5	20.3	0.7	0.4	11.3	10.5	3.5	3.3	139	136	54	71	8.3	7.4	5.8	5.3	22.46	21.21	222	218
SC-11	26.5	23	0.7	0.5	9.9	9.2	3.8	3.3	61	58	72	71	2.9	2.6	13.1	12.3	17.12	16.47	191	187
SC-12	20	17.5	0.8	0.7	8.8	7.9	2.9	2.9	331	328	35	32	8	7	25.1	24.5	21.67	20.48	277	275
SC-13	24	22.2	0.5	0.3	10.9	10.6	3.8	3.4	113	111	33	31	62	59	16.6	14.4	14.97	17.95	169	174
SC-14	17	14.6	0.7	0.5	11.8	10.5	3.8	3.8	423	416	55	54	33	31	9.8	8.4	24.82	22.62	171	169
SC-15	20.9	17.1	0.4	0.3	9.8	9.4	3.3	3.4	149	152	43	42	14.3	12.7	11.5	10.4	13.11	11.64	175	173

BH= Before Harvesting, AH=After Harvesting

Values of physicochemical parameters

Water Holding Capacity (WHC)

One of the main functions of soil is to hold onto moisture and supply it to plants between irrigations or downpours. Plant transpiration, deep percolation, and soil evaporation all contribute to the reduction of soil moisture between water applications. WHC of soil depends on soil structure[13]. In clay soil, the WHC is greater than that of sandy soil[9]. In the current study, maximum WHC was found at site 4 (29.3%) while minimum at site 5 (14.7%). WHC of the soil was decreased after paddy crop harvesting at most of the sites. The drop in WHC might be caused by the soil being saturated with water during crop growth, which closes the soil's pores. Higher soil water-holding capacity is required for crop production but in the current investigation, the WHC of the soil was determined to be quite low. The region needed regular watering, as indicated by the low WHC readings, and confirmed by site inspections.

Electrical conductivity

The intrinsic variability of paddy soils' physicochemical properties affects rice productivity. Currently, it is useless to apply agricultural fertilisers evenly throughout a field, as this might result in either an excess or a shortage of nutrients. Good agricultural practises are achievable soil and nutrient changes a soil-yield relationship is established[14,15]. The nutrient of the soil made available to the plant on moderate EC values. The salinity of the study area soil varies from moderate (3.12-6.14 Ds/cm^3) to high (8.04-23.21 Ds/cm^3). After the paddy harvesting, EC dropped at all the locations but very little variation in the EC values was observed before and after harvesting. Higher conductivity values are not good for crops since they cause plants to absorb less water[16].

Organic Carbon

Organic carbon improves crop output, soil sustainability, soil tilth, and soil fertility in agricultural settings. It is known that modifications to tillage, fertilisation, irrigation, and other practises may affect the organic content of crops[5,17]. The lowest OC (0.28%) was recorded at SC-06 while the highest OC (3.69%) at SC-15. The paddy soil in the research area is divided as having excellent fertility by Jaiswal[18]. There was a little decrease in the values of OC of soil and at certain locations the values were the same BH and AH of paddy crop. Crop frequency and the anaerobic period are closely correlated with the reduction in OC. Since OC functions as a nutrient and binds soil particles together, proper OC levels are necessary to preserve the integrity of soil[19].

pH

The greatest direct influence on rice development comes from soil pH, which also affects the equilibrium of sulphides and iron in the chemical composition, both of which pose a threat to rice when present in large quantities[20]. The pH value of the study area soil ranges between 4.1 to11.9. Of all the samples, 12% were found in acidic range while 43% in alkaline range and the other samples to be neutral or neutral. Slight shift from basic to acidic range was observed in the pH of soil BH and AH of paddy crop's. Talpur *et al.,* also noted a same downward trend in soil pH[21]. The breakdown of organic content and water seeping through soil might be the cause of the soil's pH dropping. The reduction of soil parameters to an acidic state may be caused by salt buildup from repeated irrigation operations.

Nitrogen

It is crucial to add more nitrogen to rice production systems to boost crop yield and keep up with the growing human population[22]. The sizable amount of nitrogen that was supplied to the paddy gets lost to the micronutrient, which has a lot of adverse consequences. The nitrogen content was highest (423 Kg ha^{-1}) at SC-14 and lowest (61 Kg ha^{-1}) at SC-11. Of the fifteen samples, thirteen fall into the acceptable range for nitrogen. Comparing the nitrogen levels of the paddy crop's soil BH and AH to other parameters, a significant difference was found.

Potassium

In the current investigation, the potassium content was found highest (271 Kg ha^{-1}) at SC-01 and lowest (155 Kg ha^{-1}) at SC-04. Of the fifteen samples, two fall into the low range (less than thirty) and thirteen fall into the acceptable range for potassium. Comparing the potassium levels of the paddy crop's soil BH and AH to other parameters, a significant difference was found.

Phosphorus

One of the key elements needed for plant growth is phosphorus (P). The phosphorus content was found highest (24.82 Kg ha^{-1}) at SC-14 and lowest (13.11 Kg ha^{-1}) at SC-15. Of the fifteen samples, thirteen fall into the acceptable range for phosphorus. A substantial difference was seen when the phosphorus levels of the paddy crop's soil BH and AH were compared to other parameters.

Zinc

It is necessary for the plant's ability to withstand cold temperatures, the preparation of certain carbohydrates, and transformation of starches into sugars. Zinc levels ranged from a minimum of 21.0 ppm at SC-01 to a maximum of 75.00 ppm at SC-10. At every paddy crop location (BH and AH), the levels of zinc dropped. Following the paddy crop, the soil's nature changed to a little alkaline mode, and the zinc values decreased.

Copper

Copper shortage affects photosynthesis and respiration. As a result, empty grains and spikelets might become sterile[23]. An appropriate concentration of copper decreased the occurrence of many plant diseases. Copper levels ranged from 1.1 Mg kg^{-1} at minimum at SC-08 to 64.00 Mg kg^{-1} at maximum at SC-12. The majority of the locations saw a minor rise in soil copper levels, while some also saw a drop.

Iron

For plants, iron is a necessary component. In the respiration and photosynthesis of electron-transport chains, it performs the functions of receiving and supplying electrons[24]. Iron levels ranged from a minimum of 3.6% at SC-08 to a maximum of 27.11 Mg kg^{-1} at SC-12. At every paddy crop location, the levels of iron dropped before and after the harvesting of paddy crop.

CONCLUSION

The goal of the current study was to evaluate how crop harvesting affects the condition of the soil in Mul Tehsil (M.S.), India. In this study, the paddy crop case study was selected. The results indicate that the measures like WHC were found to be in the medium range, the pH of the soil was determined to be in an alkaline medium. The soil was found to be somewhat and extremely salted. The fertility of the soil was found to be in fair condition. It is found that the ranges for iron, zinc, copper, phosphorus, potassium, and nitrogen decreased but the values currently are in acceptable. Following rice harvesting, most physicochemical metrics and micronutrient levels decreased except copper. Although the ionic balance may soon be broken by rapidly expanding human activities, which would reduce agricultural productivity, the soil was found to be in satisfactory condition at the time.

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Conflict of interest

The writers affirm that they don't have any competing interests.

REFERENCES

1. Ludwig, M.; Achtenhagen, J.; Miltner, A.; Eckhardt, K.U.; Leinweber, P.; Emmerling, C.; Thiele-Bruhn, S., *Soil Biology and Biochemistry*., **2015**, *81*, 311-322.
2. Geisseler, D.; Linquist, B.A.; Lazicki, P.A., *Soil Biology and Biochemistry*., **2017**, *115*, 452-460.
3. Puniya, R.; Pandey, P.C.; Bisht, P.S.; Singh, D.K.; Singh, A.P., *The Journal of Agricultural Science*., **2019**, *157*(3), 226-234.
4. Ruhela, M.; Bhardwaj, S.; Garg, V.; Ahamad, F., *Archives of Agriculture and Environmental Science*., **2022**, *7*(3), 379-385.
5. Weifeng, S.O.N.G.; Aiping, S.H.U.; Jiai, L.I.U.; Wenchong, S.H.I.; Mingcong, L.I.; Zhang, W.; Zheng, G.A.O., *Pedosphere*., **2022**, *32*(4), 637-648.
6. Bhutiani, R.; Ahamad, F., *Contaminants in Agriculture and Environment: Health Risks and Remediation*., **2019**, *1*, 236.
7. Carter, M.R., Gregorich, E.G. (Eds.)., *Soil sampling and methods of analysis*., **2007**, CRC press.
8. Huang, Y.; Wang, L.; Wang, W.; Li, T.; He, Z.; Yang, X., *Science of the Total Environment*., **2019**, *651*, 3034-3042.
9. Farmaha, B.S.; Singh, P.; Singh B., *Agronomy*., **2021**, *11*(7), 1284.
10. Bhardwaj, S.; Khanna, D. R.; Ruhela, M.; Bhutiani, R.; Bhardwaj, R.; Ahamad, F., *Environment Conservation Journal*., **2020**, *21*(3), 155-164.
11. Zhang, Q.; Zhou, W.; Liang, G.; Wang, X.; Sun, J.; He, P.; Li, L., *Plos one*., **2015**, *10*(4), e0124096.
12. Datta, S.P.; Meena, M.C.; Dwivedi, B.S.; Shukla, A.K. Manual on advanced techniques for analysis of nutrients and pollutant elements in soil, plant and human., **2017**, Weatville Publication House.
13. Singh, R.; Bharose, R.; Singh, V.K., *IJCS*., **2018**, *6*(6), 1803-1808.
14. Shi, J.; Ye, J.; Fang, H.; Zhang, S.; Xu, C., *Nanomaterials*., **2018**, *8*(10), 839.
15. Sun, L.; Xue, Y.; Peng, C.; Xu, C.; Shi., *J. Environmental Pollution*., **2018**, *243*, 1119-1125.
16. Negash, S.; Elema, R.; Tolosa, A. In Regional Review Workshop on Completed Research Activities., **2023**, 151.
17. Tian, K.; Zhao, Y.; Xu, X.; Hai, N.; Huang, B.; Deng, W., *Agriculture, Ecosystems & Environment*., **2015**, *204*, 40-50.
18. Jaiswal, P.C. Soil, Plant, and water analysis. Kalyani publishers., **2006**.
19. Mandal, M.; Kamp, P.; Singh, M., *Communications in Soil Science and Plant Analysis*., **2020**, *51*(4), 468-480.
20. Minasny, B.; Hong, S.Y.; Hartemink, A.E.; Kim, Y.H.; Kang, S.S., *Agriculture, Ecosystems & Environment*., **2016**, *221*, 205-213.
21. Talpur, M. A.; Changying, J. I.; Junejo, S. A.; Tagar, A. A., *Bulgarian Journal of Agricultural Science*., **2013**, *19*(6), 1287-1291.
22. Tan, K.H. Soil sampling, preparation, and analysis. CRC press., **2014**.
23. Munda, S.; Bhaduri, D.; Mohanty, S.; Chatterjee, D.; Tripathi, R.; Shahid, M.; Nayak, A.K., *Biomass and bioenergy*., **2018**, *115*, 1-9.
24. Aung, M. S.; Masuda, H., *Frontiers in Plant Science*., **2020**, *11*, 1102.