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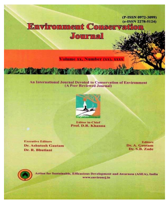

Effect of harvesting the paddy crop on the physicochemical properties and micronutrients of soil

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ABSTRACT

Soil quality plays an important role in the enhancement of agricultural Production. Therefore, the present study was carried out to study the quality of paddy soil. To fulfil the objectives of the present study, 15 sites were selected in Pomburna tehsil of Chandrapur District (M.S.), India. The systematic grid sampling plan was followed in the study and sample were selected grid wise on the basis of utilization of rice cultivated by the population cluster. Soil quality parameters such as, water holding capacity (WHC), pH, Electrical conductivity (EC), Nitrogen, Zinc, Copper, Iron, and organic carbon (OC) were analyzed during the study period. The results of the present study revealed that the value of physicochemical parameters of the soil was in the suitable range. Salinity in most of the samples (78%) was observed in high range. OC values (more than 0.80%) indicate higher fertility of the soil. The nature of the soil was found from acidic to alkaline in nature. The values of Nitrogen, Zinc, Copper, and Iron also indicate the suitability of soil for paddy crops. After the harvesting of paddy crop, the values of most of the physicochemical parameters and micronutrients decreased except copper.

Introduction

To feed a burgeoning population, agricultural production in Asia must be expand. Among all the agricultural products, rice crops require maximum quantity of water (Doran *et al.,* 1996; Bhardwaj *et al.,* 2020). Although a comprehensive evaluation of the extent of water shortage in Asian rice production is still missing, there are indications that the sustainability of the irrigated rice-based production system is being threatened by poor water quality and decreasing availability of water resources (Farmaha *et al.,* 2021). One of the key factors preventing rain-fed rice from producing a large yield is drought. For food security and maintaining environmental health in Asia, research on strategies to grow more rice with less water is crucial (Bhutiani and Ahamad, 2019; Farmaha *et al.,* 2021; Ruhela *et al.,* 2022). Numerous environmental issues, including soil acidity and compaction, have been brought on by the misuse of chemical fertilizers in recent years (Yu, 1991; Satpute *et al.,* 2013; Tian *et al.,* 2015). These issues can be efficiently resolved by substituting chemical fertilizers with organic fertilizers (Geisseler *et al.,* 2017; Weifeng *et al.,* 2022). Utilizing a soil index to evaluate the soil's fertility level might offer important insights into future plans and practical methods for achieving sustainable agriculture. When managing fertility, Soil Fertility Index (SFI) readings may be utilized to create fertility maps and provide suggestions (Munda *et al.,* 2018). As agricultural output has grown, fertilization has become a commonly utilized management technique to preserve soil fertility and crop yields (Weifeng *et al.,* 2022). The quality and fertility of the soil may be directly seen in long-term field experiments (LTFEs), which can also be used to forecast future soil productivity and interactions with the environment. Numerous long-term studies were started in previous decades to investigate the impact of fertilizer on global soil fertility (Dong *et al.,* 2012; Zhang *et al.,* 2015).

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In Pomburna tehsil many farmers cultivated in high manner crops like rice, wheat, pulses etc. to achieve a high yield. They use many pesticides and inorganic fertilizers in the wrong way without knowing that all the essential micronutrients are required to be instable soil quality. Excessive input of mineral fertilizer's and reduced use of organic fertilizer results into reduced organic carbon content of soil which results into reduces soil quality (Zhang *et al.,* 2015). Keeping in mind the above problems, study was carried out to assess the quality of soil before and after the harvesting of paddy crop in Pomburna tehsil of Chandrapur district, Maharashtra, India. The present study is first of its kind performed in Pomburna tehsil, Maharashtra.

Material and Methods

Study area

The study zone located in villages of Pomburna tehsil in Chandrapur district of Maharashtra state in India lies between north Latitudes 19.844035 and 19.814228 and East longitudes 79.65026 and 79.71392 (Figure 1). This tehsil is surrounded by Ballarshah, Gondpipari, Chamorshi, Mul, and Chandrapur tehsils and our study area is some villages of Pomburna tehsil. These villages are Kemara, Navegaon More, Dhalari, Devada, Pomburna, Velva Mal, Dewai, Chek Futana, Ashtha, Jungav, Bhatali, Chak Ashta, Chek Khapri, Dongar Haldi, and Ghatkul. Details of all the Soil Sampling sites selected are given in table 1.

Sample preparation and analysis

The soil sampling was prepared as per the standard agriculture method prescribed by Datta *et al.* (2017). Analysis of soil was performed according to standard method prescribed by several researchers (Tan, 2005; Pansu, 2006; Carter and Gregorich, 2017; Datta *et al.,* 2017).

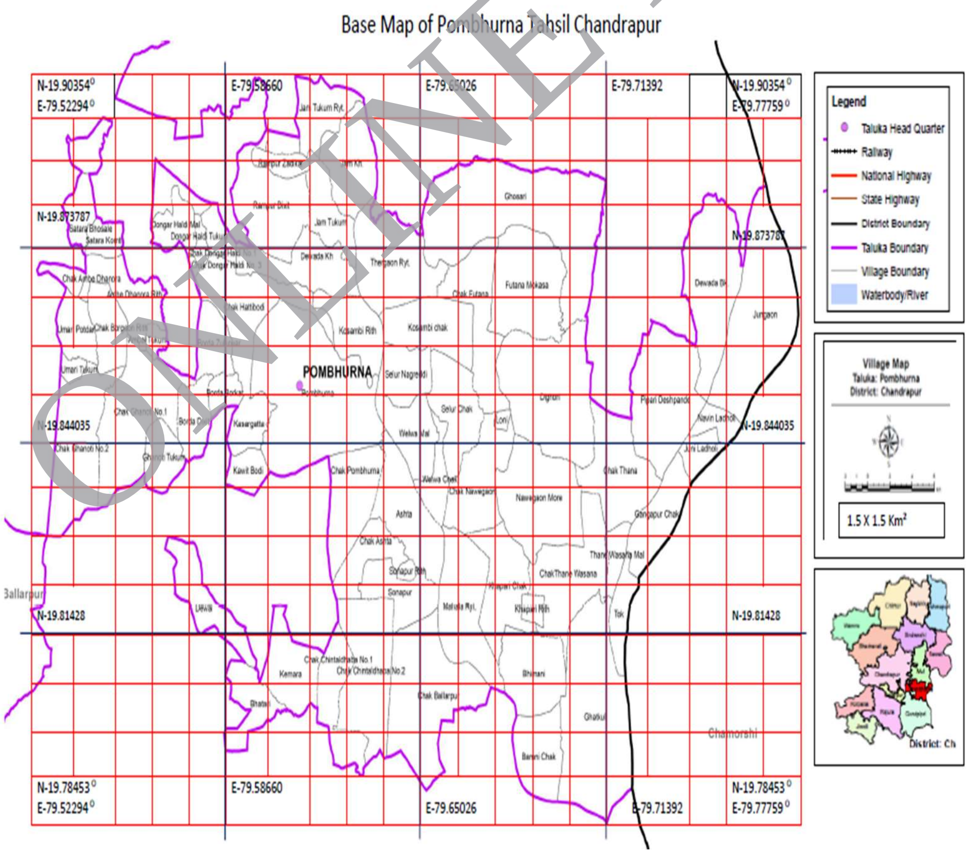

Figure 1: Showing the study area (Pombhurna Tehsil, Chandrapur, Maharashtra, India)

Table 1: Details of all the Soil Sampling sites selected in Pomburna Tehsil of Chandrapur district of Maharashtra state in India

Sample Code	Village Name	Site Code	Latitude	Longitude
MH-CH-POM-01	Kemara	SS-01	19.811647	79.620832
MH-CH-POM-02	Navegaon More	SS-02	19.795859	79.67552
MH-CH-POM-03	Dhalari	SS-03	19.862894	79.720859
MH-CH-POM-04	Devada (k)	SS-04	19.888038	79.641855
MH-CH-POM-05	Pomburna	SS-05	19.874718	79.633056
MH-CH-POM-06	Velva Mal	SS-06	19.853961	79.669736
MH-CH-POM-07	Dewai	SS-07	19.820195	79.587839
MH-CH-POM-08	ChekFutana	SS-08	19.892213	79.690823
MH-CH-POM-09	Ashtha	SS-09	19.860885	79.660662
MH-CH-POM-10	Jungaon	SS-10	19.890683	79.798834
MH-CH-POM-11	Bhatali	SS-11	19.799008	79.609528
MH-CH-POM-12	Check-Ashtha	SS-12	19.823184	79.654367
MH-CH-POM-13	Check-Khapri	SS-13	19.819763	79.716456
MH-CH-POM-14	DongarHaldi	SS-14	19.904251	79.612509
MH-CH-POM-15	Ghatkul	SS-15	19.790043	79.735623

(MH- Maharashtra, CH- Chandrapur, POM- Pombhurna)

Results and Discussion

The soil samples of the selected sites were analyzed for certain soil quality parameters such as water holding capacity (WHC), pH, electrical conductivity (EC), Nitrogen, Zinc, Copper, Iron, and organic carbon (OC). The results obtained during the study period are given in table 2.

Water holding capacity (WHC)

The ability of soil to retain moisture and provide it to plants in between rainstorms or irigations is one of its primary roles. Maximum WHC was found at SS-04 (29.2%) while minimum at SS-05 (14.8%). WHC of all the sites decreased after the harvesting of paddy crop. The reason of decrease in WHC may be that the soil becomes saturated with water during the crop and therefore the pores of soil get closed. Between water applications, soil moisture is decreased via evaporation from the soil surface, plant transpiration, and deep percolation (Xiao *et al.,* 2013; Ruhela *et al.,* 2022). WHC of soil depends of soil structure (Singh *et al.,* 2018). The WHC of sandy soil is less while that of clay soil is more (Gabler*et al.,* 2009). For sustainable productions of crop, higher water holding capacity of soil is necessary. In the present study, WHC of soil was found very low. The low WHC values indicate that the area required irrigation frequently which is also observed on site visits.

Electrical conductivity (EC)

Rice productivity is influenced by the inherently varied physicochemical characteristics of paddy soils. Currently, applying agricultural fertilizers uniformly throughout the entire field is ineffective and might lead to either an excess or a deficiency of nutrients. The EC of the study area soil varies from moderate (3.13-6.13dS/cm) to high (8.03-23.20dS/cm). Although EC decreased after the harvesting of paddy crop at all the sites but the difference between the values of EC before harvesting (BFH) and after harvesting (AFH) is very less. Higher conductivity values are not suitable for the crops as it reduces the water uptake of plants (Ameta*et al.*, 2023). If soil and nutrient changes within a farm are taken into account and a soil-yield connection is formed, good agricultural practices can be attained (Chan *et al.*, 2008). The nutrient of the soil made available to the plant on moderate value EC. Electrical conductivity (EC) is the ability of water to transmit electrical current through an aqueous solution. Ahamad *et al.* (2023a) define EC as a measure of a dissolved material's capacity to carry electricity from one pole to another.

Organic carbon (OC)

In agricultural environments, OC benefits soil fertility, soil tilth, soil sustainability, and crop yield. Minimum OC (0.29%) was observed at SS-06 while maximum (3.69%) at SS-15. Among all the 15 samples of soil, 13 samples are found to be a high range of organic carbon (<0.5), 1 medium range (0.51-0.75), and 1 sample low range (> 0.75). As per the classification of Jaiswal (2006), the soil of the study area falls in high fertility category. A slight decrease in the values of OC of soil BFH and AFH of paddy crop was observed and at some places the values were observed same in both the cases. Talpur *et al.* (2013) also observed the similar trend of decrease in soil OC. The decrease in OC is directly related to crop frequency and anaerobic period (Olk*et al.,* 1999). Agricultural management may alter OC content owing to changes in tillage, fertilization, irrigation, and other practices, as is well documented (Tian*et al.,* 2015; Weifeng*et al.,* 2022). Proper OC values are required to maintain the veracity of soil as it works as a nutrient and binds the soil particles (Mandal*et al.,* 2020).

pH

The soil pH in the study area varies from acidic (4.1) to alkaline in nature (11.9). Among all the samples, 12% of samples were found acidic in nature, 43% alkaline in nature, and rest of the samples were neutral or near neutral in nature. A slight decrease in the values of pH of soil BFH and AFH of paddy crop was observed. Talpur *et al.* (2013) also observed the similar trend of decrease in soil pH. The reason of decreasing soil pH may be decay of organic matter and percolation of water through soil layers. The chemical equilibrium of sulphides and ferrous iron, both of which are hazardous to rice when present in high concentrations, are affected by soil pH, which has the most direct impact on rice development (Yu, 1991; Snober *et al.*, 2011; Minasny *et al.*, 2016; Ruhela *et al.,* 2022; Ahamad *et al.,* 2023b). The values of soil get reduced to acidic in nature may be due to accumulation of salts due to frequent irrigation practices.

Nitrogen

Minimum nitrogen (28.6%) was observed at SS-09 while maximum (36.18%) at SS-07. Out of 15 samples, 2 samples are found to be low range (< 30) and 13 samples in an acceptable range of nitrogen (30-45). A large difference in the values of nitrogen of soil BFH and AFH of paddy crop was observed in comparison to other parameters.In order to increase crop output and keep up with the growth in the human population, nitrogen must be expanded into rice production systems, which is of utmost importance (Ruhela *et al.,* 2022). However, a sizeable portion of the nitrogen added to the rice is lost to the environment, which has a number of negative effects (Chan *et al.,* 2008).

Zinc

It is essential for the synthesis of certain carbohydrates, the conversion of starches into sugars, and the resistance of the plant to low temperatures. Minimum zinc (22.0 ppm) was observed at SS-01 while maximum (76.00 ppm) at SS-10. The values of zinc decreased at all the sites BFH and AFH of paddy crop. The decrease in the values of Zinc may be due to acidic nature of pH. The nature of the soil converted into slightly alkaline mode after the paddy crop therefore the values of Zinc also reduced. Among, which assists in stem elongation and growth control, forms when zinc is required for its synthesis (Mahata *et al.*, 2016).

Copper

Minimum copper (1.0 mg/Kg) was observed at SS-08 while maximum (63.00 mg/Kg) at SS-12. At most of the places the values of copper of soil decreased but a slight increase was also observed at some sites. Respiration and photosynthesis are impacted by copper deficiency. Spikelets and empty grains may become sterile as a result of this (Silviya and Stalin, 2017). Proper copper presence reduced the frequency of various diseases in plants.

Iron

Iron is an essential ingredient for plants. It fulfils the roles of receiving and giving electrons in the electron-transport chains of respiration and photosynthesis (Aung and Masuda, 2020). Minimum iron (3.7%) was observed at SS-08 while maximum (27.10 mg/Kg) at SS-12. The values of iron decreased at all the sites BFH and AFH of paddy crop.Talpur *et al.* (2013) studied the effect of paddy crops of soil fertility and found that most of the micronutrients decreased in the soil after the harvesting.

Table 2: Results of physicochemical and micronutrients (Nitrogen, Zinc, Copper, and Iron) parameters of the soil samples

Site Code	Water Holding Capacity (%)		Electrical Conductivity (Ds/cm3)		pH		Organic Carbon (%)		Nitrogen (%)		Zinc (ppm)		Copper (mg/kg)		Iron %	
	BFH	AFH	BFH	AFH	BFH	AFH	BFH	AFH	BFH	AFH	BFH	AFH	BFH	AFH	BFH	AFH
SS-01	26.0	24.0	0.6	0.5	4.1	3.9	1.8	1.8	34.1	33.0	22.0	20.0	5.0	6.0	23.9	21.5
SS-02	20.3	18.5	0.8	0.7	7.6	7.5	1.5	1.4	33.4	32.4	65.0	63.0	2.3	2.1	11.0	10.0
SS-03	22.3	19.0	0.9	0.6	9.5	9.3	0.9	0.8	32.3	31.3	38.0	35.0	6.0	5.0	10.8	10.3
SS-04	29.2	28.0	0.4	0.3	8.2	7.9	2.1	2.0	33.8	33.9	54.0	51.0	2.8	2.5	5.8	5.7
SS-05	14.8	13.0	0.2	0.1	4.2	3.9	0.6	0.6	33.8	31.7	66.0	63.0	5.7	5.4	9.2	8.6
SS-06	23.2	21.0	0.6	0.5	11.2	10.2	0.3	0.3	32.0	32.3	35.0	36.0	28.4	27.3	5.3	5.1
SS-07	19.5	18.3	0.5	0.3	10.5	9.5	3.0	2.9	36.2	35.2	61.0	58.0	1.2	1.3	4.0	4.2
SS-08	24.0	22.0	0.9	0.7	7.9	7.6	2.7	2.6	33.2	32.1	30.0	29.0	1.0	1.2	3.7	3.5
SS-09	23.3	22.5	0.4	0.3	8.6	8.3	0.9	0.8	28.6	25.2	53.0	51.0	16.3	15.2	6.4	5.1
SS-10	24.5	21.3	0.8	0.5	10.3	9.8	3.3	3.1	35.5	32.5	76.0	75.0	7.0	5.0	5.7	5.4
SS-11	27.0	24.0	0.6	0.5	8.9	8.2	2.8	2.3	32.6	31.1	58.0	56.0	2.0	2.5	10.4	10.1
SS-12	19.0	16.5	0.8	0.6	8.1	7.5	1.9	1.9	30.4	28.1	33.0	30.0	63.0	61.0	27.1	25.5
SS-13	23.0	21.2	0.4	0.2	11.9	10.6	2.8	2.4	28.7	25.4	39.0	36.0	7.0	6.0	12.7	11.3
SS-14	18.0	15.6	0.6	0.4	11.5	9.5	3.5	3.5	31.2	29.2	60.0	58.0	35.0	32.0	6.8	6.5
SS-15	19.9	17.5	0.3	0.2	9.9	9.2	3.7	3.7	35.4	32.4	57.0	55.0	11.3	10.5	12.1	11.2

BFH= Before Harvesting, AFH=After Harvesting

The author recommended the deep ploughing after every 4 to 5 years and input of nitrogen and organic manure after the harvesting. Sione *et al.* (2013) studied the soil quality under the influence of rice crop cultivation and observed the degradation in the quality of soil with reference to physical texture, micro and macronutrient.

Conclusion

The present study was carried out in Pomburna tehsil of Chandrapur District (M.S.), India to assess the quality of soil with reference to physicochemical and micronutrients (Nitrogen, Zinc, Copper, and Iron). The samples were collected from 15 villages of Pomburna Tehsil of Chandrapur district Maharashtra (India). The parameter such as WHC was found to be in the medium range and soil pH was found to be in an alkaline medium. The soil was found moderately and strongly saline in nature. The fertility of the soil was found in good condition. Nitrogen, Zinc, Copper, and Iron are found to be in an acceptable range. After the harvesting of paddy crop, the values of most of the physicochemical parameters and micronutrients decreased except copper. In case of copper a slight increase was observed at some sites. Presently the soil was found in suitable condition but the rapidly growing anthropogenic activities may disturb the ionic balance in near future which will result in reduces crop productivity.

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Conflict of interest

The authors declare that they have no conflict of interest.

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