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Effect of integrated nutrient management practices on soil fertility status in Amaravati and Yavatmal district (M.S.)

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Abstract
Ignored traditional soil management practices, indiscriminate use of chemical fertilizers, poor management of resources lead to the loss of soil fertility. Integrated nutrient management (INM) practices which is a combination of organic, inorganic and biological sources helps in improving and maintaining the soil fertility status along with sustainable crop yield. The effect of INM practices on soil fertility status was assessed in the study conducted for two consecutive years i.e. 2016-17 and 2017-18 in three blocks of Yavatmal and Amaravati districts of Maharashtra. Considerable improvement in macro and micronutrient status of soil was observed due to adoption of INM practices in cotton, pigeon pea and wheat crops. The results showed that the integration of organic and inorganic nutrient management practices brought down the soil from alkaline towards neutral range. Significant increase in contents of organic carbon, available nitrogen, phosphorous, potassium, sulphur, iron, zinc and boron was also recorded in soil.

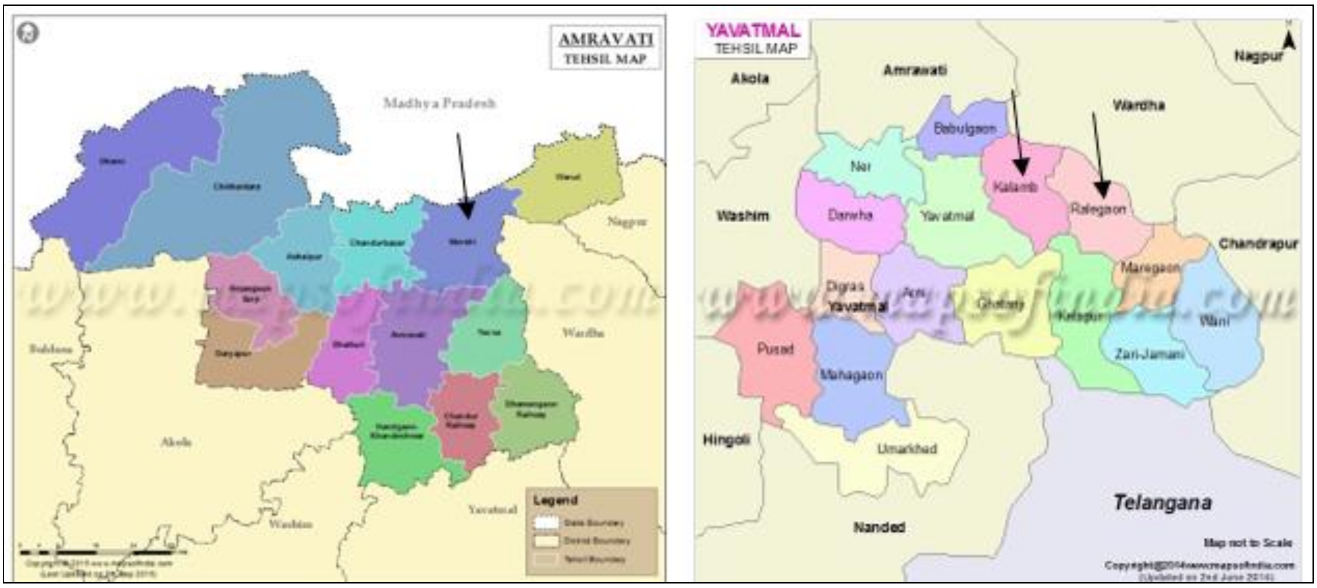
Keywords: Available nutrients, soil fertility, INM practices

Introduction
Indiscriminate applications of chemical fertilizers and the poor management of resources not only have deteriorated soil health but also have raised environmental concerns. In developing countries, harsh climatic conditions, population pressure, land constraints and ignoring traditional soil management practices have often reduced soil fertility (Debarup *et al.*, 2015) [6]. The study of Aziz *et al.*, (2019) [2] stated that the use of chemical fertilizers definitely resulted in improvement in crop growth and yield but majorly contributed to soil health deterioration. Because of this, integrated nutrient management (INM) practices are gaining more attention and importance in recent years. Integrated plant nutrient management is an intelligent use of optimum combination of organic, inorganic and biological nutrient sources in specific crop, cropping system and climatic situation so as to achieve and sustain optimum yield and to improve or maintain soil properties. Integrated plant nutrient management is beneficial to maintain soil fertility, sustainable agricultural production and increased availability of nutrients from all resources and for minimizing loss of nutrients. INM practices also contribute to optimum utilization of natural resources (Chandel *et al.*, 2018) [5].
The districts under study i.e. Yavatmal and Amaravati of Vidarbha region (Maharashtra) have rainfed farming system. It is constrained with multifarious problems such as moisture stress, soil erosion and crusting, nutrient deficiency, poor nutrient use efficiency with improper use of fertilizers, weed infestation, unsustainable farming practices etc. which are limiting the yield potential of this system (Mirza *et al.*, 2013) [11]. The reasons for low productivity of Vidarbha region as imbalanced use of fertilizers, erratic distribution of rainfall, low adoption of improved agro techniques and decline in soil health was reported by Chandel *et al.*, (2018) [5].
For addressing the issues of rainfed agriculture, low productivity and declined soil health, thus integrated nutrient management can be the way. The current study was aims to monitor the effect of INM practices on soil fertility status in Yavatmal and Amaravati districts.

Material and Methods
A. Location, climate and agriculture
The field study was performed during two subsequent years i.e. 2016-17 and 2017-18 by implementing, crop specific integrated nutrient management practices in pigeon pea, cotton and wheat crops. The targeted locations were Ralegaon and Kalamb blocks of Yavatmal district and Morshi block from Amaravati district.

The study was conducted in total 14 selected villages from all the three blocks in both Kharif as well as Rabi season.

Amaravati district is located at longitude 21.1162 ^{0}N and latitude 77.6536 ^{0}E while Yavatmal district at longitude 20.3888 ^{0}N and latitude 78.1204 ^{0}E. The average annual rainfall in Amaravati district is 889 mm while Yavatmal receives 889 to 1095 mm rainfall and is not uniform in all parts of the district. The rainfall pattern is irregular in both the districts. The climate of the districts is hot and dry in summer with moderately cold winters. The major crops grown in the districts are cotton, soybean, pigeon pea, wheat and gram. The type of the soil in the districts is mainly black (Anonymous, 2015) [1].



B. Study details

Study was conducted with a set of few integrated management practices implemented for total 60 plots of farmers' field both in 2016-17 and 2017-18. The plots size was 0.40 ha with cultivation of cotton + pigeon pea in kharif season followed by wheat in rabi season. The initial and post study soil sample collection and testing of selected plots under study was done in May, 2016 and May, 2018 respectively. The soil samples were collected at 0-15 cm depth by using standard procedures. The soil samples were tested for pH, electrical conductivity (EC), organic carbon (OC), available nitrogen (N), phosphorous (P), potassium (K), sulphur (S), iron (Fe), zinc (Zn) and boron (B). The testing of samples and generation of soil health cards were carried out by using approved soil testing kit and software developed by Indian Institute of Soil Science (IISS), Bhopal.

In the region, cotton and pigeon cropping system is followed under rainfed condition in kharif where pigeon pea is an intercrop while cotton is the main crop and wheat is cultivated under irrigated conditions in rabi. Though the said cropis under irrigation, due to low rainfall and water scarcity in the region, available irrigation water did not match crop water requirement in both the years.

During the baseline survey, it was observed that farmers were using excess chemical fertilizers than organic manures. They were not involved in production of organic manures on farm. The adopted INM practices are described below which were not followed by farmers previously.

a. **Application of organic inputs:** On an average, 2 tons of vermi-compost was incorporated in soil per acre per year. Jivamrut was also applied with water by proper dilution. Both vermi-compost and jivamrut were prepared on farm by using standard methods.
b. **Use of fertilizers as per soil test reports:** Soil samples were tested before start of the experiment. As per soil test reports macro and micro nutrients were supplied by application of fertilizers at right time and in appropriate quantities in both the years.
c. **Application of biofertilizers:** N, P, K solubilizing bacterial liquid cultures like *Azotobacter*, Phosphate Solubilising Bacteria (PSB), Potash Mobilising Bacteria (KMB) were applied through compost.
d. **Sowing method:** Use of improved sowing methods like Broad Bed Furrow (BBF) in wheat, Ridge and Furrow method in cotton resulted in optimum plant population and thus efficient use of soil moisture and nutrients by crops.

Rainfall data: According to the data from agriculture department, Govt. of Maharashtra, the average annual rainfall in 2016-17 was 977.40 mm while in 2017-18 it was 695.46 mm. In 2017-18, there was a dry spell after receipt of rainfall specifically in the month of July.

Statistical analysis: The data related with soil sample testing in 2016 and in 2018 both were compared by using z test with paired two samples for mean.

Result and Discussion

The INM practices showed increase in macro as well as micronutrients of soil along with correction in soil pH. The observed change in soil fertility status was statistically significant. The year-wise average values of physico-chemical properties (pH, EC and OC), available macro and micronutrients of soil are given below. Also, class-wise distribution of soil parameters as per ratings given by Banger and Zende (1978) [3], Lindsay and Norwell (1978) [10] and Pal (2013) [12] are mentioned.

Table 1: Soil pH

z test with paired two sample for mean	2016	2018
Mean	7.80	7.27
Observations	60	60
Hypothesized Mean Difference	0	
df	59	
P(T<=t) two-tail	8.14^{-07}	
CV (%)	6.74	6.92

*Significant at 5%, **highly significant at 1%

The data from Table - 1 showed that the pH of soil decreased from 7.80 to 7.27 after implementation of integrated nutrient management practices continuously for two years. The results are in conformity with the study conducted by Verma and Goyal (2018) [17]. It was also found that the soil samples which were previously in strongly alkaline and moderately alkaline class converted into slightly alkaline and nearly neutral class (Fig. - 1). Thus, pH get lowered towards neutral range, ultimately help to increase nutrient availability.

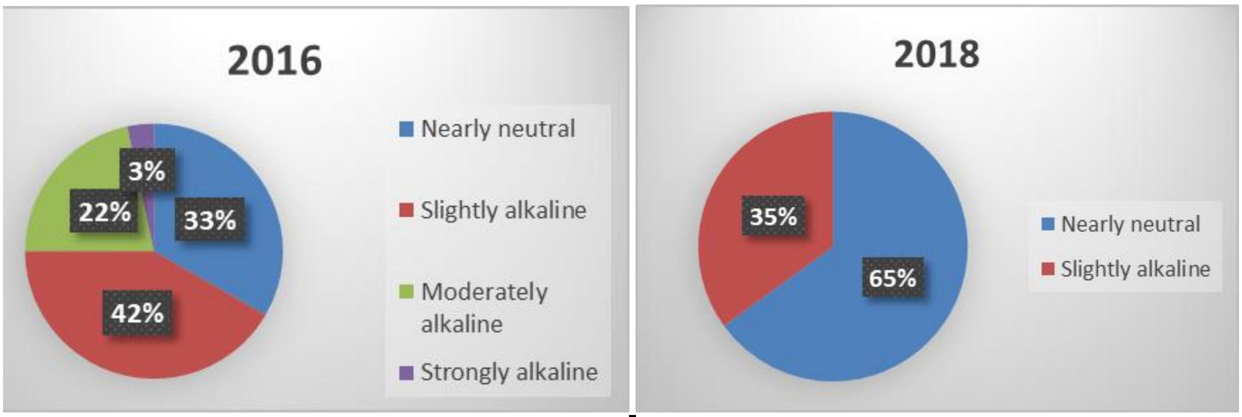


Fig 1: Class-wise distribution of soil pH

Table 2: Electrical conductivity (EC) (ds/m)

z test with paired two sample for mean	2016	2018
Mean	0.63	0.60
Observations	60	60
Hypothesized Mean Difference	0	
df	59	
P(T<=t) two-tail	0.07	
CV (%)	20.00	15.87

*Significant at 5%, **highly significant at 1%

The electrical conductivity of soil in the year 2016 was found to be 0.63 ds/m while in 2018 it was observed to be 0.60 ds/m. No significant change in case of electrical conductivity was seen (Table - 2). Similar findings were reported by Tiwari *et al.*, (2017) [16]. The data depicted in Fig. - 2 showed slight decrease in electrical conductivity of samples which were in critical class of EC and also slight increase in soil samples which had normal EC. This change in EC is expected to result in better crop growth.

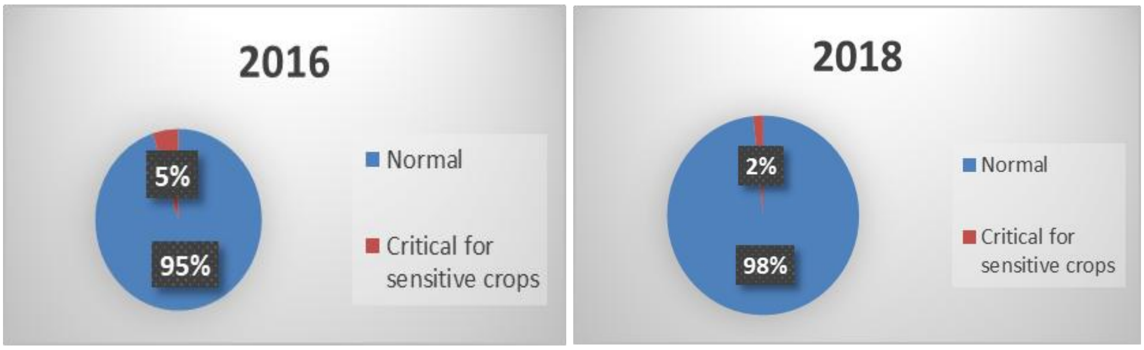


Fig 2: Class-wise distribution of EC

Table 3: Organic carbon (OC) (%)

z test with paired two sample for mean	2016	2018
Mean	0.50	0.61
Observations	60	60
Hypothesized Mean Difference	0	
df	59	
P(T<=t) two-tail	6.29^{-06}	
CV (%)	20.00	19.67

From the data tabulated in Table - 3, it was seen that the organic carbon content of soil increased significantly from 0.50 to 0.61%. Use of organic inputs treated with beneficial soil microorganisms can be the reason of increased levels of organic carbon. Khan *et al.*, (2017) [9] observed similar findings from his experiment on 'effect of INM practices on soil properties'. The data presented in Fig. 3 showed increase in samples belonging to medium and moderately high class and decrease in samples which had low status of OC. Improvement in status of organic carbon content is expected to cause soil fertility improvement.

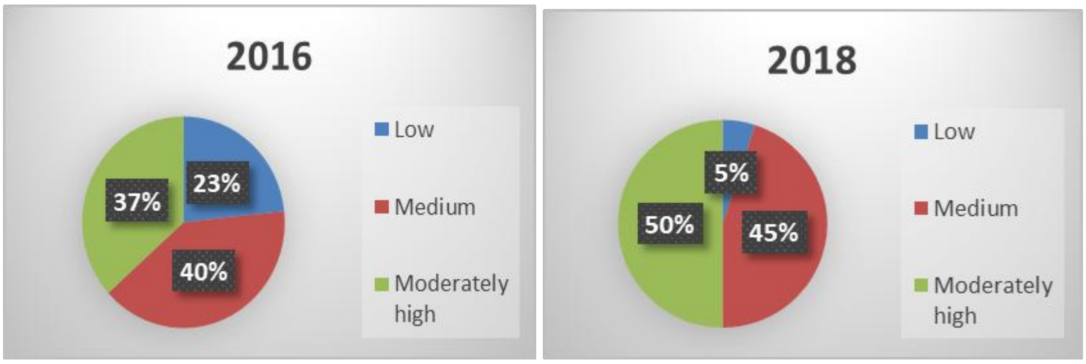


Fig 3: Class-wise distribution of OC

Table 4: Available nitrogen (N) (kg/ha)

z test with paired two sample for mean	2016	2018
Mean	255.67	276.67
Observations	60	60
Hypothesized Mean Difference	0	
Df	59	
P(T<=t) two-tail	0.01	
CV (%)	17.38	16.60

In case of available nitrogen content of soil, it was found to be 255.67 kg/ha and 276.67 kg/ha, respectively in the year 2016 and 2018. The data from Table - 4 showed significant increase in the content of available nitrogen as a result of adopted integrated nutrient management practices. The observations are in conformity with the results recorded by Kafle (2019) [8]. Further it was also observed that the number of samples in low class got reduced and while samples in medium class of available nitrogen have increased in number (Fig. - 4). This change would be favorable for plant growth.

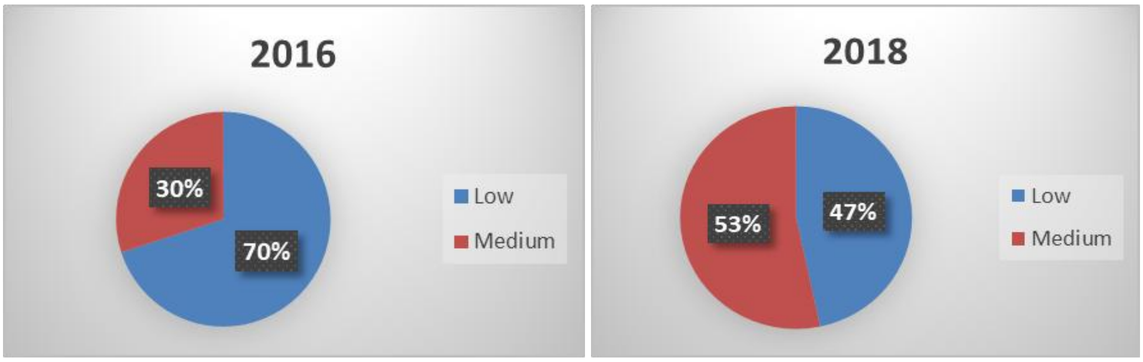


Fig 4: Class-wise distribution of available N

Table 5: Available phosphorous (P) (kg/ha)

z test with paired two sample for mean	2016	2018
Mean	28.07	33.85
Observations	60	60
Hypothesized Mean Difference	0	
Df	59	
P(T<=t) two-tail	5.35^{-08}	
CV (%)	18.88	17.40

Data presented in Table - 5 showed that the available phosphorous content of soil was 28.07 kg/ha in the year 2016 and 33.85 kg/ha in the year 2018. The increase in the content of available P was found to be statistically significant. Gudhade *et al.*, (2015) [7] also found increase in available P content by use of integrated nutrient management practices in vertisols. The data graphically illustrated in Fig. - 5 show improvement in status of available phosphorous.

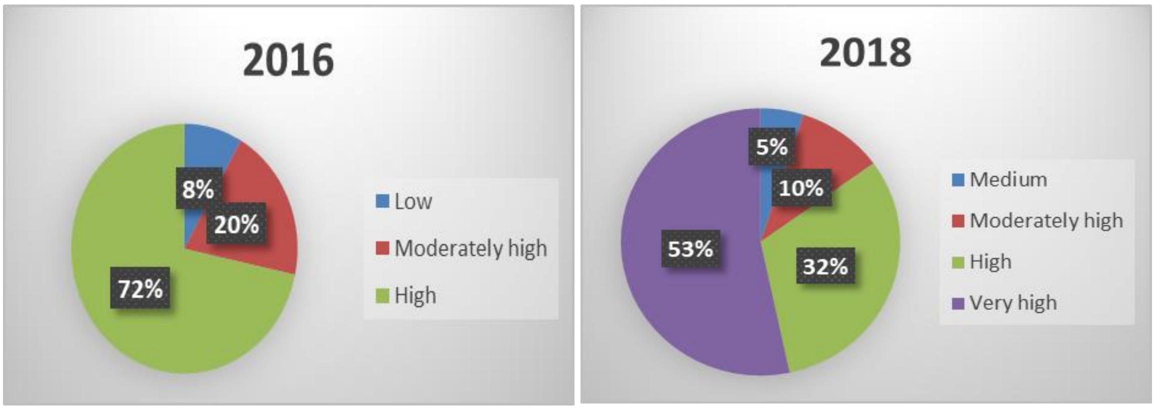


Fig 5: Class-wise distribution of available P

Table 6: Available potassium (K) (kg/ha)

z test with paired two sample for mean	2016	2018
Mean	233.89	293.26
Observations	60	60
Hypothesized Mean Difference	0	
df	59	
P(T<=t) two-tail	4.21^{-09}	
CV (%)	19.02	14.52

As seen from Table - 6, the values for available potassium in the year 2016 and 2018 were 233.89 and 293.26 kg/ha respectively. The use of INM practices in both the years resulted in significant increase in the content of available potassium. Similar observations were recorded by Yaduvanshi *et al.*, (2013) [18]. In case of class-wise distribution of available potassium content, decrease in number of samples having low status and increase in number of samples having high status was noted (Fig. - 6). This change would prove be helpful for enhancement of crop growth.

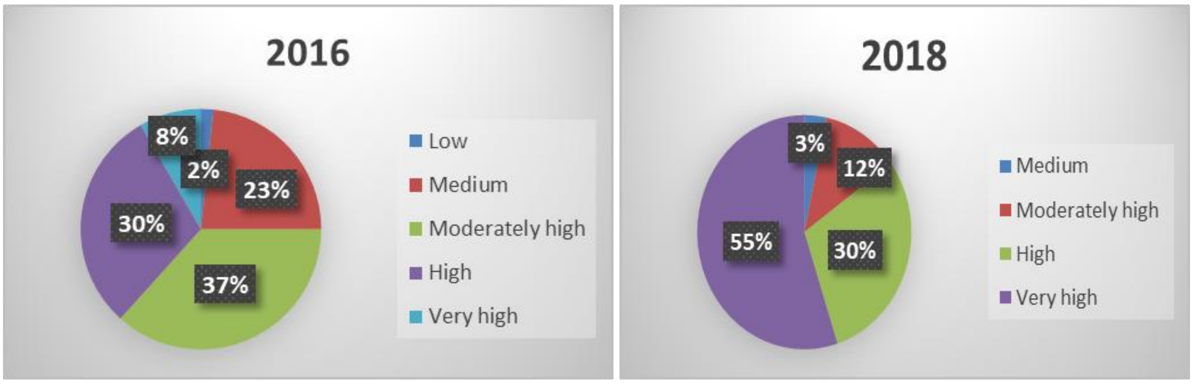


Fig 6: Class-wise distribution of available K

Table 7: Available sulphur (S) (mg/kg)

z test with paired two sample for mean	2016	2018
Mean	37.04	39.51
Observations	60	60
Hypothesized Mean Difference	0	
Df	59	
P(T<=t) two-tail	0.01	
CV (%)	18.41	13.74

Significant increase in the content of available sulphur was noticed after comparative study of two years data (Table - 7). The respective contents of available sulphur in the year 2016 and 2018 were 37.04 and 39.51 mg/kg. Singh *et al.*, (2018) [14] also showed increase in content of available sulphur from his investigation. According to the ratings given by Banger and Zende (1978) [3], the soil samples in both the years were in high class of available sulphur content.

Table 8: Available iron (Fe) (mg/kg)

z test with paired two sample for mean	2016	2018
Mean	6.01	8.00
Observations	60	60
Hypothesized Mean Difference	0	
Df	59	
P(T<=t) two-tail	4.95^{-12}	
CV (%)	18.80	14.62

From the data in Table - 8, it was revealed that the available iron content was significantly increased from 6.01 mg/kg in 2016 to 8.00 mg/kg in 2018. The followed INM practices in both the years can be linked with this significant change in the content of available iron These findings are in conformity with the observations recorded by Patil *et al.*, (2018). Further, the data depicted in Fig. - 7 showed improvement in number of samples which had deficient status of available Fe content in 2016 and thus increase in its sufficiency level in 2018.

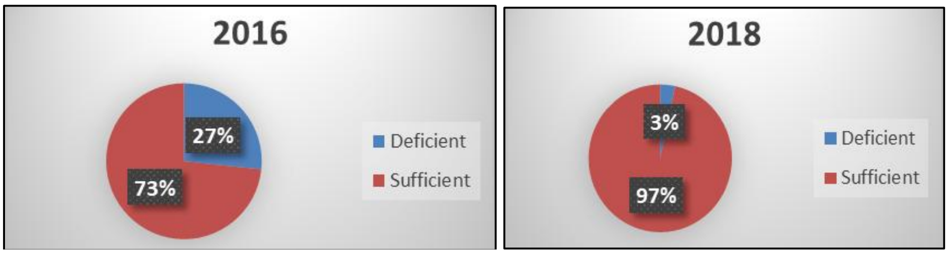


Fig 7: Class-wise distribution of available Fe

Table 9: Available zinc (Zn) (mg/kg)

z test with paired two sample for mean	2016	2018
Mean	1.21	1.30
Observations	60	60
Hypothesized Mean Difference	0	
Df	59	
P(T<=t) two-tail	0.04	
CV (%)	19.83	16.92

In case of available zinc content of soil, it was 1.21 mg/kg in 2016 while 1.30 mg/kg in the year 2018. The content of zinc was found to be significantly increased over its content before start of the trial (Table - 9). Similar results were reported by Chahal *et al.*, (2019) [4]. INM practices have not only increased the content of available zinc but have also converted more number of samples in sufficient class from deficient class.

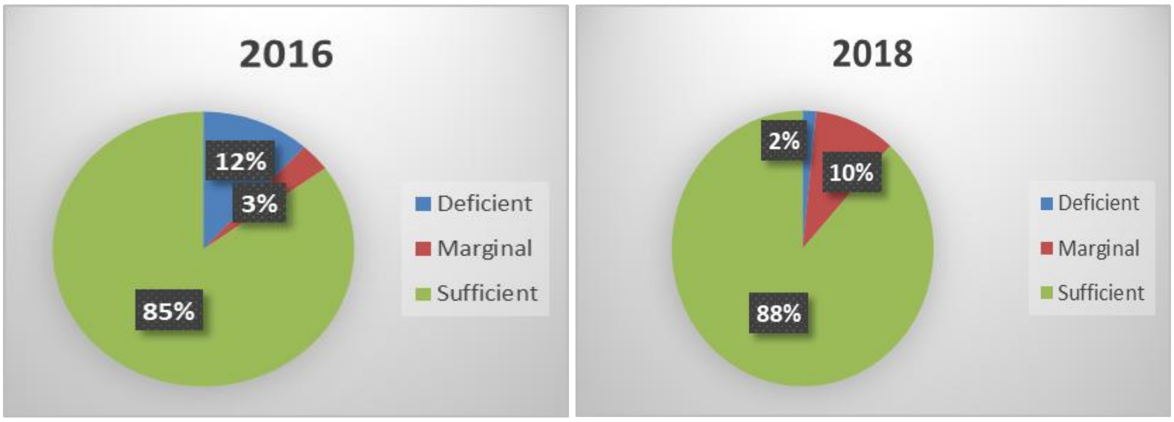


Fig 8: Class-wise distribution of available Zn

Table 10: Available boron (B) (mg/kg)

z test with paired two sample for mean	2016	2018
Mean	0.76	0.81
Observations	60	60
Hypothesized Mean Difference	0	
Df	59	
P(T<=t) two-tail	0.04	
CV (%)	18.42	16.04

Values in Table - 10 showed that the available boron content of soil were 0.76 and 0.81 mg/kg respectively in the year 2016 and 2018. The increase in content of available boron was found to be statistically significant. The results are in agreement with those of Thingujam *et al.*, (2016). From the data illustrated in Fig. - 9, it was seen that the deficiency level of available boron content decreased and hence resulted in increase in its sufficiency level.

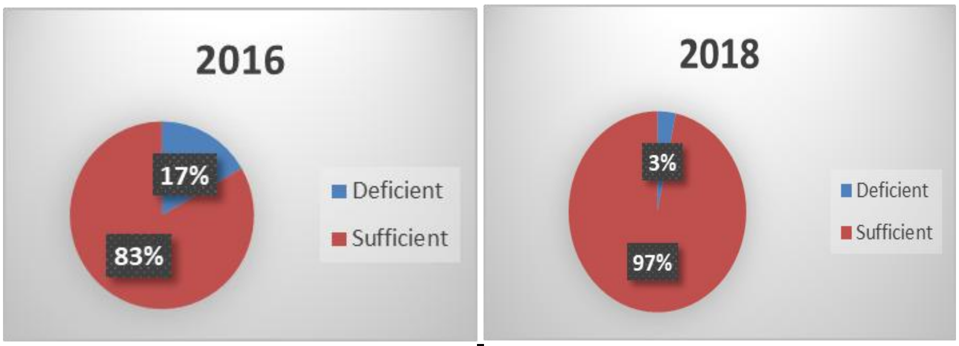


Fig 9: Class-wise distribution of available B

Summary and Conclusion

Significant improvement in soil fertility status was observed due to adoption of integrated nutrient management practices in Yavatmal and Amravati district. The data from present investigation showed significant increase in contents of organic carbon, available nitrogen, phosphorous, potassium, sulphur, iron, zinc and boron. In addition, the pH of soil decreased from alkaline to neutral level.

From the aforesaid findings, it is affirmed that the implementation of integrated nutrient management practices is crucial for improving and maintaining long term soil fertility to achieve sustainable crop production as an added benefit. Therefore, adoption of INM practices by farmers to a larger extent possible is recommended for crop production and soil fertility management.

Acknowledgement

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Reference

1. Anonymous. Impact of BT cotton: a case study of Yavatmal district of Maharashtra state, 2015. Shodhganga.inflibnet.ac.in/bitstream/10603/21062/13/15_chapter%206.pdf
2. Aziz MA, Mushtaq T, Mushtaq A, Eajaz Dar A, Mahdi SS. Effect of integrated nutrient management on soil physical properties using Soybean (Glycine max (L.) Merill) as indicator crop under temperate conditions. Chem. Sci. Rev. Lett. 2019; 8(29):123-128.
3. Banger AR, Zende GK. Soil testing: A new basis for efficient fertilizer use. J Maharashtra Agric. Univ. 1978; 3(2):81-84.
4. Chahal HS, Singh S, Singh ID, Kaur S. Effect of integrated nitrogen management on macronutrient availability under Cauliflower (*Brassica oleracea* var. *botrytis* L.) (2019). Int. J Curr. Microbiol. App. Sci. 2019; 8(4):1623-1633.
5. Chandel A, Gabhane VV, Mali DV, Patode RS, Nagdeve MB. Long term effect of integrated nutrient management on soil biological properties and productivity of cotton + green gram intercropping system in vertisols. Journal of Chemical Studies. 2018; 6(4):1537-1541.

6. Debarup D, Dwivedi BS, Meena MC, Integrated nutrient management for improving soil health and crop productivity. Indian J Fert. 2015; 11(4):64-83.
7. Gudadhe N, Dhonde MB, Hirwe NA. Effect of integrated nutrient management on soil properties under cotton chick pea cropping sequence in vertisols of deccan plateau of India. Indian J Agric. Res. 2015; 49(3):207-214.
8. Kafle K, Chandeshwar PS, Marasini M. Influence of integrated nutrient management practices on soil properties and yield of potato (*Solanum tuberosum*. L) in an inceptisol of Khajura, Banke. Int. J Appl. Sci. Biotechnol. 2019; 7(3):365-369.
9. Khan A, Kirmani NA, Wani FS. Effect of INM on soil carbon pools, soil quality and sustainability in Rice-Brown Sarson cropping system of Kashmir valley. Int. J Curr. Microbiol. App. Sci. 2017; 6(7):785-809.
10. Lindsay WL, Norwell WA. Development of DTPA soil test for Zn, Fe, Mn and Cu. Proc. Soil Sci. Soc. Amer. 1978; 42:421-428.
11. Mirza BB, Shabbir AS, Gary SS. Making rainfed agriculture sustainable through environmental friendly technologies in Pakistan: A review. International Soil and Water Conservation Research. 2013; 1(2):36 52.
12. Pal SK. Book of soil sampling and methods of soil Analysis. New India publishing Agency, 2013, 270.
13. Patil JR, Jadhao SD, Mule P, Sonune BA, Mali DV, Aage AB *et al*. Journal of Pharmacognosy and Phytochemistry. 2019; 8(4):1680-1684.
14. Singh RK, Kumar P, Singh SK, Singh SB, Singh RN. Effect on integrated nutrient management on yield and economics of mustard (*Brassica juncea* L.). Int. J Curr. Microbiol. App. Sci. Special Issue 2018; (7):5261-5269.
15. Thingujam U, Patil S, Khanam R, Pari A, Ray K, Phonglosa A *et al*. Effect of integrated nutrient management on the nutrient accumulation and status of post-harvest soil of brinjal (*Solanum melongena* L.) under Nadia conditions (West Bengal), India. Journal of Applied and Natural Science. 2015; 8(1):321-328.
16. Tiwari A, Tiwari A, Singh NB, Arvind Kumar. Effect of integrated nutrient management (INM) on soil properties, yield and economics of rice (*Oryza sativa* L.). Res. Environ. Life Sci. 2017; 10(7):640-644.
17. Nisha Verma, Sneh Goyal. Effect of organic manuring and integrated nutrient management on microbiological properties in sandy soils under wheat-guar cropping system**.** Int. J Curr. Microbiol. App. Sci. 2018; *7*(2):1340-1351.
18. Yaduvanshi NPS, Sharma DR, Swarup A. Impact of integrated Nutrient Management on Soil Properties and Yield of Rice and Wheat in a Long Term Experiment on a Reclaimed Sodic Soil (2013). Published at https: // www. researchgate.net/ publication /282787859, 2013.