EFFECT OF ORGANIC INPUTS ON SOIL PROPERTIES, YIELD AND QUALITY OF DIFFERENT CROPS UNDER CERTIFIED ORGANIC FARMS IN NAGPUR DISTRICT

THESIS

Submitted to
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola
in partial fulfilment of the requirements
for the Degree of

MASTER OF SCIENCE
IN
AGRICULTURE
(SOIL SCIENCE AND AGRICULTURAL CHEMISTRY)

By

SAWANT AKSHAY PRAKASH

SECTION OF SOIL SCIENCE AND AGRICULTURAL CHEMISTRY
COLLEGE OF AGRICULTURE, NAGPUR

DR. PANJABRAO DESHMUKH KRISHI VIDYAPEETH,
KRISHINAGAR PO, AKOLA (MS) 444104

Enrolment Number – OO/3142 **2018**

DECLARATION OF STUDENT

I hereby, declare that the experimental work and its interpretation of the Thesis entitled **"EFFECT OF ORGANIC INPUTS ON SOIL PROPERTIES, YIELD AND QUALITY OF DIFFERENT CROPS UNDER CERTIFIED ORGANIC FARMS IN NAGPUR DISTRICT"** or part thereof has neither been submitted for any other degree or diploma of any University, nor the data have been derived from any thesis/publication of any University or scientific organization. The source of materials used and all assistance received during the course of investigation have been duly acknowledged.

Place: Nagpur **(Sawant Akshay Prakash)**

Date: 11/06/2018 Enrolment No. OO/3142

CERTIFICATE

This is to certify that thesis entitled **"EFFECT OF ORGANIC INPUTS ON SOIL PROPERTIES, YIELD AND QUALITY OF DIFFERENT CROPS UNDER CERTIFIED ORGANIC FARMS IN NAGPUR DISTRICT"** submitted in partial fulfilment of the requirement for the degree of **"Master of Science in Agriculture (Soil Science and Agricultural Chemistry)"** of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola is a record of bonafide research work carried out by **Sawant Akshay Prakash** under my guidance and supervision.

The subject of the thesis has been approved by the Student's Advisory Committee.

Place: Nagpur
Date: 11 /06/2018

(Dr. Ommala D. Kuchanwar)
Chairman,
Advisory Committee

Countersigned

Associate Dean
College of Agriculture,
Nagpur

THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE INCLUDING EXTERNAL EXAMINER (AFTER VIVA-VOCE)

1. Chairman	(Dr. Ommala D. Kuchanwar)	______________
2. Member	(Dr. W. P. Badole)	______________
3. Member	(Dr. P. C. Pagar)	______________
4. Member	(Dr. Neha K. Chopade)	______________
5. External Member	(Dr. R. M. Ghodpage)	______________

Acknowledgements

I am extremely blessed individual with an overwhelming amount to be thankful for in my life. My family and friends who support me are the backbone of my personal achievements. I thank God for the patience and perseverance to not only set goals, but to have the willpower to achieve them. Pursuing a graduate degree took a leap of faith and I am proud of myself for taking that leap.

I express my deep sense of gratitude and cordially thanks to golden heart personality Dr. Ommala D. Kuchanwar, Professor (CAS), Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur and the Chairman of my advisory committee for suggesting the research topic and also taking keen interest during the course of this investigation, constructive criticism, constant encouragement and guidance, giving valuable suggestions throughout the final shaping of the research topic.

I am extremely thankful to the members of my Advisory Committee, I am very much grateful to Dr. N. D. Parlawar, Associate Dean, College of Agriculture, Nagpur and Dr W.P. Badole Head of section Soil Science and Agriculture Chemistry, College of Agriculture Nagpur. Dr. P. C. Pagar, Associate Professor of Agronomy, College of Agriculture Nagpur. Dr. Neha K. Chopade, Associate Professor, Horticulture, College of Agriculture, Nagpur for their creative criticism and suggestions in the preparation of thesis, open mind ness and for their helpful nature during the entire course of investigation and also for providing the necessary laboratory facilities.

I will be highly improper if I do not acknowledge the kind advices from Dr. S. M. Bhoyar, ex-head of Soil Science and Agricultural Chemistry and Dr. W. P. Badole, Head of section, Soil Science and Agricultural Chemistry, College of Agriculture Nagpur. Dr. S. S. Balpande, Associate Professor, Dr M. M. Raut, Associate Professor, Dr. R. M. Ghodpage, Professor (CAS), Soil Science and Agricultural Chemistry, College of Agriculture, Nagpur.

I am especially thankful to Shri. N. D. Raut, and Shri. Anil Sahare for providing laboratory facilities during analysis and for helping in computer works.

I extend my sincere thanks to my seniors Nandakishor Ghube, Nitikesh Bhujade, Satish Bodkhe, Anil Kumar, Tejashri Patekar, Bhagyashri Patil and Sindhu Rathod for their relentless help and suggestions during the analytical work.

I warmly thanks to my colleagues Nikhil Sarnaik, Indranil Pathare, Ganesh Pable, Krunal Raut, Pallavi Ghorpade, Kajal Bhoyar, Rohini Tembhurkar, Hina Raghorte, Supriya Bhakare and Dipali Dahule for their help, co-operation and constant encouragement during the course of study.

I again thankful to my juniors Prem, Yogesh, and Harish for their painstaking efforts in efficient work processing of manuscript in time. I do express my heartfelt thanks to my friends Rahul, Kiran, Vaibhav, Ashwin, Rohini and Komal for their help and constant encouragement guidance and inspiration time to time.

Finally, I have no words to acknowledge with thanks the warm affectionate love, constant inspiration and encouragement that I received from my beloved father Shri Prakash Shankar Sawant, mother Akshada Sawant and my brother Abhijeet Sawant who are the architects of my past and present and my other family members.

I am thankful to all authors whose literature has been cited in this investigation.

Above all I am once again hearty thankful to all of them who really supported me during my PG course and due to lack of space their names are not mentioned here kindly forgive.

Place: Nagpur
Date:11/06/2018

Sawant Akshay Prakash

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(D) Abbreviations

BC	-	Bio-compost
dS m^{-1}	-	Deci simen's per meter
DTPA	-	Diethylene triamine penta acetic acid
EC	-	Electrical conductivity
et al.	-	et alia (and associates)
HC	-	Hydraulic conductivity
G	-	Gram
i.e	-	That is
kg ha^{-1}	-	Kilogram per hectare
Mg m^{-3}	-	Mega gram per cubic meter
N	-	Nitrogen
mg kg^{-1}	-	Milligram per kilogram
Mm	-	Millimeter
K	-	Potassium
FYM	-	Farm Yard Manure
P	-	Phosphorous
Zn	-	Zinc
Fe	-	Iron
SOC	-	Soil organic carbon
viz.	-	Namely
Mn	-	Magnese
S	-	Sulphur
RDN	-	Recommended dose of nitrogen
CC	-	Concentrated Cake
PM	-	Poultry Manure
CCM	-	Compost cattle manure

(E) THESIS ABSTRACT

a)	**Title of the thesis**	:	**EFFECT OF ORGANIC INPUTS ON SOIL PROPERTIES, YIELD AND QUALITY OF DIFFERENT CROPS UNDER CERTIFIED ORGANIC FARMS IN NAGPUR DISTRICT**
b)	**Full name of student**	:	**SAWANT AKSHAY PRAKASH**
c)	**Name and address of Major Advisor**	:	**DR. OMMALA D. KUCHANWAR** Professor (CAS) Soil Science and Agricultural Chemistry, College of Agriculture, Nagpur.
d)	**Degree to be awarded**	:	M.Sc. (Agril.)
e)	**Year of award of degree**	:	2018
f)	**Major subject**	:	Soil Science and Agricultural Chemistry
g)	**Total number of pages in the thesis**	:	72
h)	**Number of words in the abstract**	:	438
i)	**Signature of the student**	:	
j)	**Signature, name and address of forwarding authority**	:	

Professor,

Soil Science and Agricultural Chemistry,
College of Agriculture, Nagpur

ABSTRACT

The field investigation in relation to " EFFECT OF ORGANIC INPUTS ON SOIL PROPERTIES, YIELD AND QUALITY OF DIFFERENT CROPS UNDER CERTIFIED ORGANIC FARMS IN NAGPUR DISTRICT" was carried out during kharif- rabi season of 2017 - 18 at the certified organic farmer's fields of Nagpur district to assess the soil properties, quality and yield different crops as influenced by various organic resources. Soil samples of 0-20 cm depth were collected randomly after the harvest of crops from six locations viz., Selu, Kalmeshwar, Gangner, Saoner, Chacher and Chinchbhavan of Nagpur district were selected for recording various observations and collected plant samples for quality parameters. Yield of crops was noted from farmer's field of above locations.

The certified organic farmers applying FYM @ 2.5 to 10 t ha^{-1}, Ghanjivamrut 500 kg ha^{-1} and Jivamrut 500 lit ha^{-1} from last 7 to 17 years for different crops.

The results revealed that soil pH was reduced due to continuous application of various organic sources to field. However, electrical conductivity of soil (0.215 to 0.316 dS m^{-1}) remained almost unchanged due to incorporation of organic and inorganic sources. The application of organic inputs increased organic carbon by 2.47 to 46.48 % at different locations over fertilizer applied field.

The application of organic sources from 7 to 17 years resulted in maximum available N content of soil by 2.08 to 44.18 % over the application of fertilizers alone. The available P content of soil after harvesting of crops varied from 15.26 to 30.00 kg ha^{-1} and comes under medium to high range categories. The application of organic sources from 7 to 17 years decreased soil available potassium by 1.26 to 11.95 % over inorganic. The variation in available sulphur (11.03 to 14.61 mg kg^{-1}) was observed and it found low to moderately high amount in all locations.

The use of FYM, manurial liquid and solid organic source was found useful in maintaining the available micro-nutrient status of soil over the continuous use of fertilizer. The maximum microbial count was recorded in organic field over the inorganic field. The count of bacteria, fungi and actinomycetes were varied from 16.25 to 22.50 X 10^7 cfu g^{-1}, 10.75 to16.25 X 10^5 cfu g^{-1} and 7.25 to 13.5 X 10^5 cfu g^{-1} respectively. Correlation matrix observed that $CaCO_3$, N, K, Cu and Mn maintained positive relationship with the yield of mandarin crops. Where as EC, OC and N were positively correlated with yield of rice crop.

From the study it can be concluded that, the application of organic inputs improve the chemical, biological properties and fertility status of soil. In case of yield due to organic sources littilbit decreased.

Chapter I

INTRODUCTION

1. Background Information

Organic farming was practiced in India since thousands of years. The great Indian civilization thrived an organic farming and was one of the most prosperous country in the world, till the British ruled it. In traditional India, the entire agriculture was practiced using organic techniques, where nutrient, pesticides, etc. were obtained from plant and animal products. The cow not only provided milk but also provided bullocks for farming and dung which used as fertilizer.

The government intends to bring 10 lakh hectares of land under organic farming till 2015 against 6.50 lakh hectare at present. Organic agriculture is economic production management system that promote and enhances biodiversity, biological cycle and soil biological activity. It is based on minimal use of farm inputs on management practices that restore, maintain and enhance ecological harmony. Organic farming, in spite of the reduction in crop productivity by 9.2 %, provided higher net profit to farmers by 22.0 % compared to conventional farming. This was mainly due to the availability of premium price (20-40 %) for the certified organic produce and reduction in the cost of cultivation by 11.7 %. In India about 528,171 hectare area in under organic farming with 44,926 number of certified organic farms. This accounts for about 0.3 % of total agricultural land (Ramesh *et al.*, 2010).

Soil health was a key founding principle for the development and practice of organic farming. Such farming practices, combined with the proper management of the farm and concurrently available renewable resources, can result in the rejuvenation of the soils and sustainable, improved crop productivity. Effective use of farmyard manure, vermicompost and organic liquids are a key to nutrient cycling on organic farms. These organic fertilizers enhance the soil physical, chemical and microbial properties, so that it can become a potential alternative to conventional farming systems and assesses the impacts on soil macro and micronutrients of organic farming. It also identifies and assesses soil processes regulated by microbes under organic and conventional management practices (Hampton *et. al.*, 2011).

Organic farming may be defined comprehensively as environment friendly ecological production system that promotes and enhances biodiversity, biological cycles and biological activities. It is based on minimum use of off-farm inputs and management practices that restore maintain and enhance ecological harmony (Narayanan, 2005).

Organic farming is a production system which avoid or largely excludes the use of chemical fertilizer, pesticides and growth regulators. It also depends upon crop rotation with leguminous crops, addition of crop residues, manure, green mauring, bio-fertilizers and bio-pesticides etc. According to estimate 201 MT of crop residues and 287 MT of dung, 184 MT of rural compost and 12.2 MT of city compost are available which can provide 9 MT of nutrient the quantity equivalent to about 40 % of nutrient supplied by fertilizers at present (Bhumbla, 2010).

Soil organic matter is responsible for maintenance of not only the soil physical conditions of the soil but also supplies essential plant nutrients for successful crop production. Humus, most important and largest constituent of soil organic matter, is formed by the decomposition of plant and animal residues by micro-organisms. It is a store house of various nutrients essential for plant growth. Besides, humus also exerts a pronounced influence of physical, chemical and biological properties of soil. (Gathala et *al,* 2007).

Soil organic matter (SOM) has been called “the most complex and least understood component of soils”. Simply put, soil organic matter is any soil material that comes from the tissues of organisms (plants, animals, or microorganisms) that are currently or were once living. Soil organic matter is rich in nutrients such as nitrogen (N), phosphorus (P), sulfur (S), and micronutrients, and is comprised of approximately 50 % carbon (C).of soil health. Organically rich soil helps to increase availability of nutrients and micro-nutrients.

The influence of organic and conventional management practices on soil chemistry, microbial activity and biomass has been extensively studied. Soil is complex mixture of minerals, oxides, organic matter, microorganism and other compounds that have been produced during the soil formation process, which provides and extremely large variety of soil. In particular, the topmost layers of agricultural soil are very delicate and dynamic in their behavior.

1.1 Importance of study

A large percentage of the earth's active carbon (C) is deposited in soil organic matter (SOM), and its cycling rate is tightly linked to nitrogen availability in natural and managed ecosystems (Gardenas *et al*., 2011). SOM turnover, the formation of dissolved organic N (DON), and its subsequent turnover to inorganic N play a key role in soil fertility and available nutrient supply to both vegetation and soil microorganisms. Excessive and continuous use of inorganic fertilizers is deteriorating soil quality and crop productivity (Dave *et al.,* 2003) with the inevitable price rise of fossil fuels that most occur over the next few decades due the depletion of petroleum reserves and increased production cost of other fuels. Now is the time that alternative strategies for nitrogen supply should be developed before these increased costs force the farmer to cut nitrogen inputs which will result in drastic yield reductions.

Addition of organic amendments could represent important strategy to protect agricultural land from excessive soil resources exploitation and to maintain soil fertility. Soil organic matter is key component because it Influence soil physical, chemical and biological properties that defined soil productivity and quality (Doran and Parkin 1994).

One of the main challenges in organic production is the approach to soil fertility, as is expressed in regulations on permitted fertilizer and soil amendments. Soil fertility management in organic farming system is based on an appropriate crop rotation design, crop residue management, and application of manure as well as compost and digestates (in the following referred to as based organic fertilizer) completed by several permitted commercial fertilizers and soil conditioners.

It has been possible to use of organic resources in appropriate quantity for long term under different cropping system, due to continuous use of organics gives response to different major and micronutrients which has, vital role in crop growth and soil quality. In some area of Vidarbha region the farmers are adopting different types of organic source to cereal and horticultural crops and this is need to study the impact of long term organic farms distribution pattern of DTPA extractable of micronutrients and physical indices in the Nagpur district.

Organic farming has been considered as one of the best options for protecting sustaining soil health and productivity and is gaining lot of importance in present-day agriculture. Significant improvements in soil physical, fertility and biological properties have been reported in several organic farming experiments although grain yield under organic farming is often less than under conventional farming due to so-called organic transition effect.

1.2 Objectives of studies

1. To assess the chemical and biological properties of soil under long term organic farming.
2. To study the quality parameters of different crops.
3. To study the correlation between soil properties and yield of different crops.

1.3 Hypothesis

The balanced application of organic nutrients source can enhance the condition of soil and yield of crop. Gathala *et al.* (2007)

resulted the SOM is responsible for the maintenance not only the soil physical condition of soil but also supplies essential plant nutrients for successful crop production. The continuous application and adequate quantity of different organic sources (solid / liquids) is important to maintain the soil health and affect the nutrient use efficiency, biological properties and productivity reducing the loss of fertilizer N and reducing K and micronutrients. Mponya *et al*. (2014) reported that, the soil organic carbon significantly improved with the application of organic manures at higher levels. Due to continuous use of chemical fertilizer may cause imbalance in microflora and directly affected the biological properties. Scanty information is available on effect of amrutpani, jivamrut and ghanjivamrut on microbial populations, physico-chemical properties of soil and yield of various crops.

1.4 Scope and limitation

The economics of organic farming is characterized by increasing profits via reduced water use, nutrient-contamination by pesticides, reduced soil erosion and carbon emissions and increased biodiversity. Organic farming produces the same crop variants as those produced via conventional farming methods, but incurs 50 % lower expenditure on fertilizer and energy, and retains 40 % more topsoil. This type of farming effectively addresses soil management. Even damaged soil, subject to erosion and salinity, are able to feed on micro-nutrients via crop rotation, inter cropping techniques and the extensive use of green manure. The use of liquid manures, green pesticides such as Neem, and compost tea is environmental friendly and non-toxic.

Organic farming helps to avoid chain reaction in the environment from chemical sprays and dusts. It also helps to prevent environmental degradation and can be used to regenerate degraded areas. Since the basic aim is diversification of crops, much more secure income can be obtained than when they rely on only one crop or enterprise.

Organic products have high alimentary value but at the same time an exceptional flavor. They are foods with big content in natural sugars, metals, micronutrients, vitamins, antioxidant cells and have small content in water. Finally, supporters of organic foods claim that the reduced amounts of pesticides and chemicals in organic foods protect children and can prevent cancer, allergies, birth defects, nerve damage, genetic mutation and asthma. Organic agriculture is definitely more sustainable in the long-term, improving soil fertility and terrain drought resistance greatly. These farming practices completely waive off external costs, incurred due to investment in chemical pesticides and nutrient runoff, and a number of health issues that result from agro-chemical residue.

It has been found that organic farming reduces the production cost by about 25-30 %, as it does not involve the use of synthetic fertilizers and pesticides, which thus makes organic farming cost effective. Soil is the most important component in farming and organic farming preserves soil by reducing soil erosion up to a large extent.

1.5 Limitations

Availability of organic sources are inadequate. Organic farming is labour intensive in comparison to inorganic farming. The yield level losses may observed during the initial period. In some case, if excess application of organic matter, during the decomposition of organic manures, the soil releases nitrates which through percolation can pollute groundwater.

Chapter II

REVIEW OF LITERATURE

A comprehensive review of literature is essential in any research endeavour. It makes the researcher up-to-date with the theoretical knowledge and findings of research in the field of investigation. The main functions of the review of literature are to determine what work, both theoretical and empirical has already been done previously, provide a basis for research frame work, suggest operational definitions of major concepts and provide a basis for interpretation of findings. Present chapter tries to put the chain of thinking of the researcher about the synthesis of various findings related to the topic of research.

Organic farming has been considered as one of the best options for sustaining soil health and productivity and is gaining lot of importance in present-day agriculture. Significant improvements in soil physical, fertility, and biological properties have been reported in several organic farming experiments.

The literature pertaining to the different aspects under investigation with special emphasis on "EFFECT OF ORGANIC INPUTS ON SOIL PROPERTIES, YIELD AND QUALITY OF DIFFERENT CROPS UNDER CERTIFIED ORGANIC FARMS IN NAGPUR DISTRICT'' is briefly reviewed under the following heads.

2.1 Chemical properties of soil under long term organic farming.

2.2 Effect of organic farming on micronutrients in soil.

2.3 Biological properties of soil under long term organic farming.

2.4 Effect of various organic sources on yield and quality of crops.

2.5 Correlation between soil properties and yield of crops by use of organic inputs.

2.1 Chemical properties of soil under long term organic farming.

More (1994) observed that, the application of FYM @ 25 t ha^{-1} plus pressmud @ 20 t ha^{-1} was the best for increasing yields of rice and wheat, decreased the pH and ESP of the soil. The infiltration rates increased due to application of organic wastes and manures. The application of pressmud, dried biogas slurry, FYM, and wheat straw increased the status of organic carbon, available N, P and K of soil.

Kleinman *et al.* (2000) reported that, the available P was significantly increased in the soil amended with 10 t FYM ha^{-1} + 10 t sewage sludge ha^{-1}. Available P in soil was 1.9 times higher in treated soil with 10 t FYM ha^{-1} + 10 t sewage sludge ha^{-1} as compared to control.

Sudhakar *et al*. (2002) reported that, vermicomposting is the process by which we can convert organic waste into rich humus by using earthworms. Vermicompost contains micro sites rich in available carbon and nitrogen.

Katyal *et al*. (2003) reported that, the plots which received FYM @ 20 t ha^{-1} recorded the highest organic carbon content. This might have been due to the direct incorporation of organic matter, better root growth and more plant residues addition on realizing higher crop yields.

Ramesh *et al.* (2005) reported that, organic farming system rely on the management of soil organic matter to enhance the chemical, biological and physical properties of the soils.

Sleutel *et al.* (2006) reported that, long-term applications of animal manure increase SOM and decreases calcium carbonate content in two ways by adding OM contained in the manure and by increased OM in crop residues due to higher crop yields in soil.

Gathala *et al*. (2007) reported that, the soil organic matter is responsible for maintenance of not only the soil physical conditions of the soil but also supplies essential plant nutrients for successful crop production. Humus is the most important and largest constituent of soil organic matter formed by the decomposition of plant and animal residues by micro-organisms. It is a store house of various nutrients essential for plant growth. Besides, humus also exerted a pronounced influence on physical, chemical and biological properties of the soil.

Abuzara and Tahboub (2008) observed that, initially high content of calcium carbonate in soil conventional (22.38) and control treatment (22.05), organic matter applied soil relatively low calcium carbonate content poultry manure (19.55) and sheep manure (19.78).

Chhibba (2010) reported that, the incorporation of crop residues and FYM alone or in combination with green manuring significantly increases the organic carbon content because residues with wider C:N ratio and high humification co-efficient than green manuring possibly leave more C in soil for conservation to soil organic matter.

Kumar *et al.* (2010) reported that, the green manuring treatments were compared with FYM and $ZnSO_4$ application. The organic carbon and DTPA-Zn content decreased vertically with increase in soil depth after completion of 4^{th} cropping cycle. Among green manures (dhaincha) was more effective in enhancing organic carbon and DTPA-Zn content in soil. However, green manure along with 5 t FYM ha^{-1} was most effective among all the treatments. The DTPA-Zn showed positive correlation with organic carbon content indicating that application of organics increases the organic matter content that provides chelating agents for complexation of native or added Zn.

Hampton *et al*. (2011) studied on the soil chemical properties in response to applications of bio solids by the end of the experiment reported that, there were more than ten times greater in the amended soils than non amended soil. Soil CEC of amended soil was about 2.5 times that of non amended soils. They reported that, Soil OM, pH, and extractable P, K, Ca, Mg, Mn, Cu, Fe, and Zn concentrations were higher in the organic amendment treatments than the control, except for Mn.

Thakur *et al.* (2011) reported that, saturated HC value was maximum under 100 % NPK + FYM @ 15 t ha^{-1} (1.11 cm hr^{-1}) as compared to 100 % NPK (0.69 cm hr^{-1}) indicates the favorable effect of FYM on HC of soil.

Angan and Yaganoglu (2012) reported that, farmyard manure and sewage sludge improved significantly the SOC content of soil over control. The SOC content was higher (0.46 %) under 10 t FYM + 5.0 t sewage sludge ha^{-1} which was on par with all the treatments except control (0.29 %). However, the increase in SOC content as compared to initial value could be a result of direct addition of FYM and sewage sludge as well as their beneficial effect on crop roots and on total microbial biomass of soil.

Radhakrishnan *et al.* (2013) showed that, organic management enhanced yield by 8 % over conventional practice. At the end of second year, the pH was significantly higher in the organic practice (5.864) and organic C status was raised by 9.5 % over the conventional system. There was no significant difference in the status of available N, P and K (after second crop) or secondary and micro nutrients (after first crop). However, exchangeable Ca, Mg, Fe, Cu and Zn were slightly favoured under organic practice.

Surekha and Satishkumar (2013) stated that, organic farming has been considered as one of the best options for sustaining soil health and productivity and is gaining lot of importance in present-day agriculture. Significant improvements in soil physical, fertility, and biological properties have been reported in several organic farming experiments. Organic sources provide a stable supply of C and energy for microorganisms and cause an increase in the microbial biomass pool, thereby increasing soil respiration rate. Greater respiration rates in organically managed soils than in conventionally managed soils and favorable improvement in soil physical, fertility, and biological properties were reported in organic farming experiments.

Kusro *et al.* (2014) concluded that, soil fertility status significantly increased with the application of organic and inorganic combination 100% NPK +FYM integrated treatment from initial to final stage of the soil after thirteen years. Applications of organic sources with inorganic sources were found more effective in building up soil fertility status as compared to inorganic fertilizer alone.

Patel *et al.* (2014) concluded that, FYM as organic amendment was found superior in respect to yield, nutrient uptake, produce quality and residual soil fertility status at equivalent N application rate followed by integrated application of equivalent amount of FYM and VC. Maize + soybean–tomato cropping system produced maximum system productivity and gave the highest net returns

Patel and Saraf (2014) observed that, availability of nitrogen (N) is lower at lower pH and improves in a quadratic fashion with increasing pH until around 7.0. The increase in N availability is associated mainly with improved activity of N turnover bacteria. The availability of phosphorus (P) is associated with neutralizing of aluminum (Al), manganese (Mn), and iron (Fe) compounds, which fix this element at lower soil pH.

Shaikh and Gachande (2014) reported that, organic inputs applied field, there was significantly minimum and maximum increase in soil properties like organic carbon (0.11 % to 0.34 %), phosphorus (6.62 kg ha^{-1} to 15.16 kg ha^{-1}), water holding capacity (3.3 % to 8.5 %) over inorganic inputs applied field. There is significantly decrease in pH (0.79 to 1.23) and Electrical conductivity (0.07 dS m^{-1} to 0.36 dS m^{-1}) of soil in organic field compared to inorganic field. The potassium content was higher in both fields. From above finding it is clear that, application of organic inputs like farm yard manure, Beejamruth and Jeevamruth significantly improves soil nutrient properties which results in increase in fertility and productivity of soil for sustainable development.

Shukla *et al*. (2014) reported that, addition of organic amendments could represent an important strategy to protect agricultural lands from excessive soil resource exploitation and to maintain soil fertility. Soil organic matter is a key component because it influences soil physical, chemical and biological properties that define soil productivity and quality.

Jothimani *et al.* (2014) studied on practices of organic farming, combined with the proper management of the farm and concurrently available renewable resources, can result in the rejuvenation of the soils and sustainable, improved crop productivity. Effective use of farmyard manure, vermicompost and organic liquids are a key to nutrient cycling on organic farms. These organic fertilizers enhance the soil physical, chemical and microbial properties, so that it can become a potential alternative to conventional farming systems.

Mponya *et al*. (2014) reported that, the soil organic carbon significantly improved with the application of organic manures at higher levels (15 t ha^{-1}). Bokashi manure was superior in improving the organic carbon on the experimental site.

Rajashekarappa *et al.* (2014) reported that, sunhemp in-situ green manuring recorded numerically higher organic carbon of (0.47%) closely followed glyricidia green leaf manuring (0.46%) and horsegram intercropping (0.46%). Lowest bulk density of 1.42 Mg m^{-3} recorded by sunhemp in situ green leaf manuring and horse gram intercropping and highest bulk density of 1.47 Mg m^{-3} was noticed in tank silt application treatment. Significant improvement in available soil nutrients (N,P and K) and organic carbon content due to in situ green manuring with sunhemp.This may due to addition of organic matter through incorporation of sunhemp as in situ and glyricidia leaves and horse gram intercropping.

Meena *et al.* (2015) indicated that, organic carbon, available nitrogen (N), phosphorus (P), potassium (K) and lower bulk density were observed in farmyard manure applied equivalent to 120 kg N $ha^{–1}$ followed by vermicompost equivalent to 120 kg N $ha^{–1}$. Grain yield of popcorn was significantly higher in the treatments of recommended dose of fertilizers and vermicompost equivalent to 120 kg N ha^{-1}.

Ramani *et al.* (2016) reported that, numerically lower value of soil pH 7.63 was found under 25 % N through BC : VC : CC + green sesbania mulch 5 t ha^{-1} and higher value of soil pH 8.02 was recorded under 50 % N through BC : VC : CC + sugarcane trash @ 2 t ha^{-1}.

Sihi *et al.* (2017) observed that, enhanced availability of nutrients in organic fields can be influenced by favorable soil pH. In this regard, soil pH was 0.5 unit lower in organic fields as compared to conventional fields. The near neutral soil pH values in organic systems may have contributed to help increase the availability of major and micro nutrients in original alkaline soils. Our finding of declining soil pH with organic manure applications resemblances with others , which are associated with the formation of humus and organic acids on decomposition. The soil EC was 26 % lower in organic systems than in the conventional system. It is likely that higher EC values in conventional fields are associated with excessive salts accumulations from chemical fertilizer usage.

Prajapati and Swaroop (2018) concluded from trial that, the various levels of different sources in the experiment, the treatment T8-L2 V2-[@ 100 % NPK + 100 % vermicompost] was found to be the best in increasing physical and chemical properties of soil bulk density (1.35 Mg m^{-3}), particle density (2.56 M gm^{-3}), pore Space (47.51 %), pH (7.19), EC (0.23 dS m^{-1}), organic carbon (0.70 %), N (209.25 kg ha^{-1}), P (19.61 kg ha^{-1}) and K (132.45 kg ha^{-1}) were found to be at par than any other treatment combinations.

2.2 Effect of organic farming on micronutrients in soil.

Mishra *et al.* (2008) reported that, the micronutrient content of soil after 3 cycles was the highest with FYM application and the least with summer fallow. Green manured and wheat straw applied plots were at par and had significantly less Zn content in soil than FYM applied plots but significantly more than fallow plots. As regards Cu, only wheat straw application and fallow plots were significantly inferior to FYM.

Patel and Das (2009) reported that, a good amount of total micronutrients *viz*. Fe, Mn, Zn and Cu were present in PM and BC, but the contents varied appreciably depending upon the sources of PM and BC which calls for thorough monitoring (including ETPS) under field condition to avoid any toxic effect on soil-water-plant-environment in the long run.

Panwar *et al.* (2010) reported that, the organic matter treatment had significantly greater Fe, Mn, Zn, and Cu content than inorganic treatment and integrated management treatment 7.34, 11.15, 0.83, 1.43 mg kg^{-1}, 5.49, 9.47, 0.63, 1.28 mg kg^{-1}, 6.73, 10.64, 0.77, 1.38 mg kg^{-1} respectively.

Hampton *et al.* (2011) revealed that, long term application of organic amendments improve physical, chemical and biological properties of soil by increasing OM, C and P, K, Ca, Mg and micronutrients concentrations by increasing overall soil microbial activity, and decreased bulk density.

Yonar *et al*. (2011) reported that, percentage of macronutrients in compost poultry manure (CPM) N, P, K, Ca, Mg and S recorded 2.0, 1.9, 1.5, 5.0, 0.7 and 0.4, respectively. Similarly, the value of micronutrients (ppm) Fe, Cu, Mn, Mo, B and Zn recorded 1.3, 66.0, 180, 3.5, 6.0 and 164.0 respectively, and percentage of macronutrient in Compost Cattle Manure (CCM) N, P, K, Ca, Mg and S recorded 1.5, 0.8, 4.5, 2.1, 0.9 and 0.5 respectively, and micronutrient (ppm) Fe, Cu, Mn, Mo, B and Zn observed 2.0, 51.0, 180, 3.5, 6.0 and 164.0, respectively.

Calero *et al.* (2012) reported that, organic soils had a slightly lower pH than in conventional soils, and organic amendments improve the availability to plants of several micronutrients (Fe, Mn, Zn, etc.) in the organic plots.

Meena *et al*. (2013) reported that, the sewage sludge is rich in organic matter and plant nutrients especially nitrogen, phosphorus, calcium and micronutrients and can improve soil physical, chemical and biological properties of soil.

Kharche (2013) reported that, the application of FYM significantly increased availability of micro-nutrient over rest of treatments probably due to decomposition of FYM. Addition of organic material might have enhanced the microbial activity in the soil and consequently the release of complex organic substances.

Yadav *et al*. (2013) reported that, the application of various organic sources, increased significantly the DTPA-Zn in soil over control. DTPA-Zn soil were recorded 0.67, 0.74 and 0.62 mg kg^{-1} with application of 10 t FYM, 5 t PM and 5 t Pim ha^{-1}, respectively whereas control recorded o.57 mg kg^{-1} DTPA-Zn in soil.

Moharana *et al.* (2017) reported that, the higher values of available zinc (Zn) (1.54 mg kg^{-1}) and iron (Fe) (5.68 mg kg^{-1}) were maintained in FYM+NPK treated plots, while higher values of manganese (Mn) (6.16 mg kg^{-1}) and copper (Cu) (1.07 mg kg^{-1}) were found in FYM alone at surface soil as compared to subsurface soil.

2.3 Biological properties of soil under long term organic farming.

Mandal *et al.* (2006) observed that, the microbial biomass and soil enzyme activities were controlled by the long-term manure and fertilizer treatments and physiological stages of wheat crop (rhizosphere feed back) and their interactions. Microbial biomass and microbial activities were highest in NPK+FYM treatment at maximum tillering, followed by flowering and dough stages.

Marinari *et al.* (2006) studied the long term application of manures and fertilizers in maize-wheat-cowpea cropping system for 26 years on inceptisols and reported that, dehydrogenase activity increased significantly under integrated nutrient management.

Manna *et al.* (2006) reported that, soil microbial biomass carbon (SMBC), nitrogen (SMBN) and acid hydrolysable carbohydrates (HCH) were greater in NPK + FYM and NPK + lime as compared to other treatments. With three decades of cultivation, C and N mineralization were greater in microaggregates than in small macroaggregates and relatively resistant mineral associated organic matter (silt + clay fraction).

Mandal, *et al.* (2006) investigated the effect of six long-term (34-year) fertilizer and farmyard manure (FYM) treatments (Control, N, NP, NPK, NPK+S, NPK+FYM) and three physiological stages of wheat growth on the microbial biomass carbon (MBC), nitrogen (MBN) and dehydrogenase, mineralizable N and phosphatase activities in soil. It was found that a balanced application of NPK+FYM gave the highest values for the measured parameters and lowest at the control. Values were generally highest at tillering, followed by the dough stages of wheat.

Saha *et al.* (2008) reported that, dehydrogenase activity basically depends on the metabolic state of the soil biota. A significant increase in dehydrogenase activity occurred in the plots with organic treatments, especially with NPK. Activity of urease was significantly higher in plots under control followed by NPK, FYM and NP treated plots.

Diacono and Montemurro (2009) studied that, the quantity and quality of organic material added to soils are the major factors in controlling the abundance of different microbial groups and the activity of microorganisms involved in nutrient cycling. Enzyme activity and microbial biomass analysis indicated that microbial properties were stimulated, e.g. microbial biomass C increased to about 100%, more by high rates and composted than by low rates and fresh paper mill residuals.

Katkar *et al*. (2010) was undertaken an experiment during 2007–08 to study the effect of long-term fertilization and manuring on soil chemical and biological properties in Vertisol. Significantly highest increase in soil organic carbon and total nitrogen were recorded with 100 % NPK + FYM @10 t ha^{-1}. The availability of N, P, K, S, soil microbial biomass carbon and nitrogen, dehydrogenase assay and productivity of sorghum and wheat were significantly increased with the integrated application of organic manure (FYM @ 10 t ha^{-1}) and mineral fertilizer (100 % NPK) over control and other fertilizer treatments after 20 years of experimentation. Highly significant positive correlation of total productivity was observed with available K, N, and P, whereas moderately positive significant correlation was observed with organic carbon, total nitrogen and biological parameters.

Chinnadurai *et al*. (2013) studied and reported that, application of organic amendments expanded the eubacterial communities and favoured some of the phyla like *Acidobacteria* and *Actinobacteria*, and biological properties were beneficially affected due to long-term organic manures. Mineral fertilizer application, in contrast, had less impact on soil biological activities and also altered the eubacterial community diversity.

Ingle *et al.* (2014) results thus suggested that, the application of organics in combination with inorganics favorably helps in augmentation of beneficial microbial population and their activities such as organic matter decomposition, biological nitrogen fixation, phosphorous solubilization and availability of plant nutrients. Increase in microbial population with application of fertilizer nutrients is indicative of the improvements in biological soil health.

Jothimani *et al.* (2014) studied and reported that, organic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony.

Simon, and Czako (2014) revealed that, farmyard manure significantly increased hot water soluble C compared to the control. Dehydrogenase activity was significantly increased by all treatments compared to control. The results indicated that, additions of organic matter from various sources differ in the effects on soil organic matter and biological activity. The effect of manure was the most favourable; long-term application of cattle slurry + straw is rather similar to mineral fertilization.

Sharma and Subehia (2014) revealed that, the applications of 100 % NPK to both rice and wheat alone or 50 % N through FYM plus 50 % NPK through chemical fertigation (T) recorded significantly increased the SMBC value (225.7 and 273.2 mg g^{-1} soil) similarly dehydrogenase activity increased from 2.94 mg TPF g^{-1} in control to 12.04 mg TPF g^{-1} h^{-1} under T_3.

Moharana *et al.* (2014) revealed significant variation in dehydrogenose activity in soils due to different nutrient management. They reported that, plot received FYM and RP enriched compost resulted an increase in DHA by 39.3 and 47.1 percent over control respectively. It was also evident that plot received 100 % NPK increased DHA by 31.7 % over control. DHA increased further due to joint use of either FYM or RP enriched compost both 50 % NPK by 53.9 and 69.5 %, respectively.

Mali *et al.* (2015) suggested that, the long-term use of organics in conjunction with fertilizers is beneficial for improving soil biological health and crop productivity of swell-shrink soils under continuous cropping. On the other hand, soil biological properties declined due to continuous skipping of organics.

Nath *et al.* (2015) also observed that, DHA activity (µ TPF g^{-1} soil 24 h^{-1}) increased the value of 36.6, and 46.9 per cent with RDF and biofertilizer + compost @ 1 t ha^{-1}, respectively over control.

D.Souza *et al.* (2017) concluded that, the addition of organics under the integrated with inorganics maintained the organic matter levels in soil, thereby improving microbial status, enzyme activity and enhancement of population of beneficial microbes.

Parmar and Thakur (2017) showed that, soil microbial properties due to management practices increased in surface depth and observe decreasing trend with increased soil depth (Table 2). The organic practice in comparison to inorganic and integrated practice recorded higher growth of bacteria (8.6 and 4.8 106 cfu g^{-1}), fungi (4.5 and 1.6 106 cfu g^{-1}) and phosphatase enzyme (9.3 and 3.9 µ p-nitrophenol g^{-1}) in top layer than sub surface depth.

Kaur *et al.* (2017) concluded that, microbial inoculants had significant effect on dynamics of rhizospheric soil across-the-board. Addition of consortium biofertilizer increased the total bacterial population, fungal population, diazotrophic population, PSB population and PGPR population while actinomycetes population remained unaffected. The improvement in soil enzyme activities was also observed in soil samples treated with biofertilizers.

Ambadi *et al.* (2018) showed that, application of recommended FYM @ 3 t ha^{-1} 15 days before sowing along with 50 kg of nitrogen and 25 kg of phosphorus ha^{-1} at the time of sowing recorded higher up-take (227.3, 75.7 and 141.7 kg ha^{-1}, respectively), soil bacteria (45.4 ×107 cfu g^{-1} of soil), fungi (39.7 ×104 cfu g^{-1} soil) and actinomycetes (23.9 ×103 cfu g^{-1} soil) populations at harvest and soil fertility status (234.0, 87.0 and 519.7 kg N P_2O_5 K_2O ha^{-1}) followed by use of compost @ 3 t ha^{-1} prepared with Cotton stalks + Redgram stalks + *Glyricidia* green biomass with initial C:N ratio of 30:1 of the mixed composting material.

2.4 Effect of various organic sources on yield and quality of crops.

Rawat and Pareek (2003) reported that, the effects of FYM on N, P and K content of wheat grain and straw increased with increasing rates of FYM and the N, P and K uptake of the crop also increased with increasing rates of FYM.

Patel and Das (2009) reported that, the pressmud and biocompost, these two popular sources of organic manures, are largely used by farmers in South Gujarat for crop production with the comprehension that these have much more beneficial effect over FYM in obtaining higher yield and monetary return.

Surekha and Rao (2009) reported that, in the first year, the treatment that had received green gram either alone (T_3) or along with paddy straw (T_5) recorded significantly higher grain yield than all other treatments.

Siavoshi *et al.* (2011) observed that, effect of organic fertilizer on growth and yield components in rice, grain yield and its components were significantly increased in all the treatments over control. The maximum grain yield in 2008 (4335.88 kg ha^{-1}) was noted in plants treated with 2 t ha^{-1} organic fertilizer and it was (4662.71 kg ha^{-1}) for 2009 for plant treated with combination of chemical fertilizer + 1.5 t ha^{-1} organic fertilizer.

Balpande *et al* (2013) reported that, the increased in yield of wheat due to manurial liquid without RDF combination in range of 9.24 to 21.67 % over control. This indicates the role manure liquid in plant nutrient supply system.

Krishnakumar *et al.* (2013) reported that, the use of organic manures in one form or the other has advantages like nutrient conservation, slow release, improvement of soil physical conditions and enhanced biological activities resulting in higher crop yields.

Kumar *et al*. (2013) revealed that, the application of FYM + panchagavya (3 %) was found effective and showed better performance on growth and bulb yield of onion (17.4 ha^{-1}) and the plot applied with NPK + FYM resulted more bulb yield of onion (19.87 t ha^{-1}).

Yadav *et al*. (2013) reported that, the application of various organic manures the grain yield of rice increased significantly over control, however these organic manures were at par with respect to grain yield of rice. Maximum response (19.8%) was observed with the application of PM followed by FYM (16.5%) and PiM (14.8%).

Mponya *et al*. (2014) reported that, the application of organic manures at higher levels significantly increased grain, biological and stover yield and growth parameters of maize. The highest grain, stover and biological yield (3200, 5980 and 9180 kg ha^{-1} respectively) was attained under application of vermicompost at 15 t ha^{-1}. Farmyard manure did not significantly impact on the maize productivity in comparison to vermicompost and bokashi manures.

Chaudhary and Tehlan (2014) observed the yield of fenugreek 1.78 and 1.80 t ha^{-1} when the application of poultry manure (1.5 t $acre^{-1}$) and FYM 5 t $acre^{-1}$ whereas 2.07 t ha^{-1} with 15:20:10 NPK $acre^{-1}$ they further reported that application of rhizobium + FYM @ 5t $acre^{-1}$ recorded the yield of fenugreek i. e. 1.98 t $acre^{-1}$.

Singh *et al.* (2014) reported that, the grain yield of wheat were increased when 120 kg N ha^{-1} + FYM @ 6 t ha^{-1} (5.87 t ha^{-1}) where as grain yield of wheat (5.11 t ha^{-1}) was obtained with 120 kg N ha^{-1} alone under tillage condition.

Pal *et al.* (2015) observed that, the maximum total soluble solids, ascorbic acid, total sugars, reducing sugar, non-reducing sugar with the application of (T6) FYM 50 % + vermicompost 50 % fallowed by T8 (Urea 50 % + PSB 1 kg ha^{-1}) and minimum was recorded under control.

Yadav and Garg (2015) concluded that, if soil is fortified with appropriate quantities of vermicompost, the chickpea production per unit area could be enhanced significantly.

Nishan *et al.* (2016) reported the loss grain yield of rice to the tune of 15.25 per cent in organically grown rice over INM treatment they further reported that application of 100% and 70% RDN through organic sources had favourable effect on yield, might be due to enhanced availability of major and minor nutrients from FYM and vermicompost. .

Das *et al.* (2017) studied and reported that, most of the produce quality parameters of tomato and carrot were better under organic relative to inorganic farming. Thus, the study indicated the opportunity of organic farming in the agro-climatic condition of studied ecosystem and supported the hypothesis that continuous organic farming promotes soil quality and sustains crop productivity.

Khanam *et al.* (2017) indicated that, application of integrated use of 50 % recommended dose of inorganic fertilizers (50:30:30 NPK kg ha^{-1}) with organic manure (vermicompost @ 2.5 ton ha^{-1}) markedly improved the growth and floral characters and flower yield of *Gladiolus hybridus*, besides the maintenance and improvement of soil fertility.

Toppo *et al.* (2017) showed that, the best result on growth and yield of field Pea (*Pisum sativum* L.) in comparison to other treatment combination. It was recorded from the application of biofertilizers in treatment T_7 [(@ 100 % FYM: PSB + 100 % neem cake)] was found to be the best treatment. it could be recommended for profitable production of field pea (*Pisum sativum* L.) var. Icarus.

2.5 Correlation between soil properties and yield of crops by use of organic sources

Bridgit and Potty (2002) found that, increasing the FYM level increased the number of roots per plant and average root length. Maximum correlation was observed between root number per plant and grain yield, straw yield and total biomass, followed by the difference in total dry weight between flowering and panicle initiation stages of wheat.

Mandal *et al.* (2006) revealed that, soil microbial biomass carbon and soil microbial biomass nitrogen are maximum at tillering stage of wheat coincided with the highest dehydrogenase activity (20.0mg TPF kg^{-1} ha^{-1}) in the soil at treatment 100 % NPK + FYM.

However, unlike MBC and MBN, dehydrogenase activity was significantly higher in the dough (16.3 mg TPF $kg^{-1}ha^{-1}$) than in the flowering (14.0 mg TPF kg^{-1} ha^{-1}) stage particularly in India; which represents strong correlations with crop yields in many previous soil test crop response studies.

Li *et al.* (2010) reported that, long term organic and inorganic fertiliazation increased MBC, respiration and enzyme activities indicating higher microbial activity. Such an increase in microbial activity could be the result of enhancement of SOM in soil as indicated by positive correlation of enzyme activities with soil organic carbon. Organic manure supply available nutrients that can accelerate the multification of microorganism and enzyme activities.

Chaudhry *et al.* (2012) reported that, study of application chemical and organic amendments demonstrated that, organic amendment can enhance the population of certain bacterial phyla which can be correlated with other soil properties such as pH, total organic C, total organic N, and microbial biomass C.

Chinnadurai *et al.* (2013) reported that, soil acid phosphate and alkaline phosphate activities were higher in manure amended soil, and were positively correlated with SOC and MBC, suggesting that SOC and MBC were built upon continuous application of organic amendments. Organic matter acts as nutrients supplement and affords as source for enzyme as well as substrates for hydrolysis.

Kumar *et al.* (2014) reported that, the dehydrogenase activity and substrate induced soil respiration against heat stress showed a significant correlation (R2 = 0.86) indicating their strong association even after stress. Dehydrogenase activity represents active intracellular hydrogen acceptors and occurs in all living cells; hence, their activity level is strongly correlated with the activity level and quantity of total living organism as well as their substrate availability, which also represents SIR.

Moharana *et al.* (2014) observed that, soil organic carbon was significantly and positively correlated with mineral, P and K in both wheat and green gram, Similarly mineral N showed positive correlation with N, P, K, DHA alkaline and acid phosphorylation activity. They also reveal that K maintained the positive relationship with DHA activity and alkaline phosphotage.

Moller and Schulthei (2015) noticed that, the EC is not only influenced by the common salt content (NaCl), but also by many essential plant nutrients like the cations Ca^{2+}, Mg^{2+}, K^{+} as well as NH_4^{+} and the anions NO_3^{-}, SO_4^{2-}, PO_4^{3-} which are depleted from the soil if applied inappropriate amounts. Furthermore, in organic fertilizers, the anion fraction can also be built up by organic acids, which are degraded biologically after soil application and do not influence the soil salt content over a longer period. Therefore, most of the desired elements in organic fertilizers are positively correlated with the EC, and organic amendments with high nutrient concentrations potentially are also high in salt content.

Chapter III

MATERIAL AND METHODS

The field investigation in relation to "EFFECT OF ORGANIC INPUTS ON SOIL PROPERTIES, YIELD AND QUALITY OF DIFFERENT CROPS UNDER CERTIFIED ORGANIC FARMS IN NAGPUR DISTRICT", was conducted during kharif-rabi season of 2017-2018 at the certified farmer's fields (organic field) of Nagpur district. The details of materials used and methods adopted during the period of investigation are given in this chapter under appropriate heads.

3.1 Basic resource information

3.1.1 Experimental site

The field experiment entitled "EFFECT OF ORGANIC INPUTS ON SOIL PROPERTIES, YIELD AND QUALITY OF DIFFERENT CROPS UNDER CERTIFIED ORGANIC FARMS IN NAGPUR DISTRICT", was carried out at the certified organic farmer's fields of Nagpur district. Survey and samples were taken on organic and in the vicinity of organic farms (farmer's field) from Kalmeshwar, Saoner and Mauda tehsil of Nagpur district.

3.1.2 Soil of experimental area

The soil under the area of certified farms was medium to deep black (Vertisol) and well drained. In order to study the chemical properties and biological properties of soil, a soil samples were taken from 0-20 cm depth, from randomly selected spots over the field after harvest. Soil sample from all location was analyzed for various soil properties in order to assess the fertility status of soil. The chemical and biological characteristics that are determined in the laboratory and method adopted are presented in table 1. The result of all soil parameters has been reflected under the chapter of result and discussion.

3.1.3 Description of soil

The soil of the certified organic farmer's field was clay in texture. The results of the soil analysis indicate that the soil was slightly alkaline in reaction with medium to high in organic carbon, low to medium in available nitrogen and available phosphorus and very high in available potassium. The value of soil pH was in the range of 7.01 to 8.12 and electrical conductivity recorded in between 0.212 to 0.316 dS m^{-1}. The status of micronutrients Zn, Fe, Mn and Cu recorded 0.48 to 0.72, 6.33 to 8.82, 4.21 to 7.83 and 2.65 to 4.51 mg kg^{-1}, respectively.

3.1.4 Climate and weather conditions

Nagpur is situated at 21° 10' North latitude and 79° 19' East longitude at the elevation of 321.26 m above sea level and lies under sub tropical zone. Nagpur is characterized by hot and dry summer and fairly cold winter. This area shows wide diurnal fluctuation in temperature. The maximum and minimum temperature ranged from 29.6^{0}C to 45.3^{0}C and 9.9^{0}C to 19.4^{0}C, respectively, whereas the relative humidity varied from 20 to 72 per cent during the crop growth period, mean annual precipitation is about 994.8 mm. major amounts of it is received from June to September month with 47 rainy days.

The meteorological data in respect of rainfall, humidity, maximum and minimum temperatures during course of study for the period from, June 2017 to February 2018 are furnished in Appendix1.

3.2. Experimental details

The six locations of Kalmeshwar, Saoner and Mauda tehsil were selected

Locations : Chacher, Saoner, Selu, Kalmeshwar, Gangner and Chinchbhavan

District : Nagpur

Collection of soil samples:

Sr. No.	Villages	Date	Soil sampling (Depth)
1	Chacher	19/12/2017	0-20 cm
2	Saoner	21/12/2017	0-20 cm
3	Selu	28/01/2018	0-20 cm
4	Kalmeshwar	28/01/2018	0-20 cm
5	Gangner	30/01/2018	0-20 cm
6	Chinchbhavan	29/01/2018	0-20 cm

3.2.1 Details of crops adopted locations

Location	Crops		Source
Selu	1)	Mandarin [e]	Organic
	2)	Mandarin	Fertilizer
	3)	Tomato [e]	Organic
	4)	Tomato	Fertilizer
Kalmeshwar	1)	Fenugreek+ Spinach [d]	Organic
	2)	Inorganic	Fertilizer
Gangner	1)	Mandarin [e]	Organic
	2)	Mandarin	Fertilizer
	3)	Rice [b]	Organic
	4)	Soybean [d]	Organic
	5)	Inorganic	Fertilizer
Saoner	1)	Pigeonpea [c]	Organic
	2)	Pigeonpea	Fertilizer
	3)	Wheat [a]	Organic
	4)	Sweet orange [e]	Organic
	5)	Inorganic	Fertilizer
Chacher	1)	Rice [b]	Organic
	2)	Rice	Fertilizer
	3)	Mandarin [e]	Organic
	4)	Soybean [c]	Organic
	5)	Inorganic	Fertilizer
Chinchbhavan	1)	Mandarin [e]	Organic
	2)	Sorghum (Maldandi) [b]	Organic
	3)	Onion [a]	Organic
	4)	Inorganic	Fertilizer

Plate No 1: Collection of soil sample

Plate no. 2 : Reduction of sample size by quartering method

3.2.1 Use of organic sources

Table 1. Quantity of organic manure (t ha^{-1}) and organic liquids (lit ha^{-1}) used by the farmers.

Location	Crops	Quantity applied (t ha^{-1} or lit ha^{-1} or kg ha^{-1})
Selu	Mandarin	Ghanjivamrut 500 kg ha^{-1}
	Tomato	Ghanjivamrut 500 kg ha^{-1}
Kalmeshwar	Fenugreek+Spinach	Jivamrut 500 lit. ha^{-1}
Gangner	Mandarin	Ghanjivamrut 500 kg ha^{-1}
	Rice	FYM 5 t ha^{-1}
	Soybean	Jivamrut 500 lit. ha^{-1}
Saoner	Wheat	FYM 10 t ha^{-1}
	Pigeonpea	FYM 2.5 t ha^{-1}
	Sweet orange	Ghanjivamrut 500 kg ha^{-1}
Chinchbhavan	Mandarin	Ghanjivamrut 500 kg ha^{-1}
	Sorghum (maldandi)	FYM 5 t ha^{-1}
	Onion	FYM 10 t ha^{-1}
Chacher	Mandarin	Ghanjivamrut 500 kg ha^{-1}
	Rice	FYM 5 t ha^{-1}
	Soybean	FYM 2.5 t ha^{-1}

Procendure:

Jivamrut:

1) It was prepared in proportion of cow dung 10 kg + cow urine 10 liters + jaggery 2 kg + gram flour 2 kg and half kg soil from bunds also used and 200 lit. water.

2) The above material were poured in the plastic drums and mixing the all materials continue until they are thoroughly mixed.

3) It was stirred properly 2-3 times with wooden stick in a day for increasing aeration and enhancing microbial activity and keep it for one week.

4) It was diluted 100 lit. water with 10 lit jivamrut and applied dose @ 500 lit ha^{-1}.

5) The whole process was made and left in the shade to increase the activity of microorganisms.

Ghanjivamrut:

1) Make a pit size of 10 : 5 : 2.5 feet diamension. Take 500 kg fresh FYM and add 50 lit. jivamrut in the pit.

2) Cover properly the mixture with any straw material available, wait for one week for decomposition of material.

3) After one week the properly mix the mixture of FYM and jivamrut.

4) Fallow the similar process for 3-4 times at an interval of one week.

5) If procedure properly followed 40-45 days is required to complete the material of ghanjivamrut.

3.3 Soil and Plant sampling

A soil sample of (0-20 cm) depth and grain samples was taken from the sites of the farmer's field after harvest. The soil samples were dried in shade and gently grind with mortar and pestle and sieved through 2 mm sieve and for determination of organic carbon grind soil

Plate no. 3: Preparation of jivamrut

Plate No.4: Preparation of FYM

samples were passed through 0.5 mm sieve. These samples were stored in polythene bags and were subsequently analyzed for pH, EC, organic carbon, available N, P, K, and S, hydraulic conductivity, bulk density, micronutrients (Fe, Mn, Zn and Cu), microbial count and plant samples were analyzed for quality parameters (Protein ,Oil and Ascorbic acid).

3.4 Details of methods of soil analysis

3.4.1 Soil Chemical Properties

3.4.1.1 Soil reaction (pH)

The pH of soil was determined by using glass electrode pH meter (Jackson, 1973).

3.4.1.2 Electrical conductivity (dSm^{-1})

The EC (dSm^{-1}) of soil was determined by using Conductivity meter (Jackson, 1973).

3.4.1.3 Organic carbon (g kg^{-1})

It was assessed by wet oxidation method given by Walkley and Black (1934).

3.4.1.4 Calcium carbonate

The $CaCO_3$ was determined by Rapid titration method (Piper, 1966).

3.4.1.5 Available nitrogen (kg ha^{-1})

Available nitrogen in soil was estimated using alkaline permanganate method (Subbiah and Asija, 1956).

3.4.1.6 Available phosphorus (kg ha^{-1})

Available phosphorus in soil was determined by Olsen's method using spectrophotometer (Olsen's and Sommer, 1982).

3.4.1.7 Available potassium (kg ha^{-1})

Available potassium in soil was extracted by neutral ammonium acetate solution and determined using flame photometer (Jackson, 1973).

3.4.1.8 Available sulphur (kg ha^{-1})

It was determined by turbidimetric method given by Chesnin and Yien (1951).

3.5 Available micronutrients (mg kg^{-1})

DTPA (Diethylene triamine penta acetic acid) (0.005 M) extractable (1:2, soil: DTPA), Fe, Mn, Zn and Cu were determined as per the procedure outlined by Lindsay and Norvell (1978) using Atomic Absorption Spectrophotometer.

3.6 Soil Biological Properties (Microbial Count)

3.6.1 Collection of soil sample for microbial count

For determination of microbial count, soil samples at depth 0-10 cm depth were collected from different location.

3.6.2 Determination of microbial count from the soil sample

Soil microbial count was determined by serial dilution plate technique (Dhingra and Sinclair, 1993). In this technique one gram of soil sample was taken under aseptic condition in 10 ml sterile test tube and added 9 ml distilled water, shaked thoroughly for uniform mixing and form suspension. Then 1 ml suspension transferred in a 10 ml test tube and added 9 ml distilled water in it, shake the test tube well and diluted 10 times by distilled water to get desired water level of 10^{-5},10^{-6}, 10^{-7}, 10^{-8} and 10^{-9} dilutions. After dilution transferred 1 ml of suspension in petridish in particular media for specific growth of micro-organism as follows.

3.6.3 Media Preparation

3.6.3.1 For Bacteria

Nutrient Agar (NA) Media

Peptone	:	5 gm
Beef extract	:	3 gm
Agar	:	20 gm
Distilled water	:	1000 ml

3.6.3.2 For fungi

Potato Dextrose Agar (PDA) Media

Potato	:	200 gm
Dextrose	:	20 gm
Agar	:	20 gm
Distilled water	:	1000 ml

3.6.3.3 For Actinomycetes

Potato Dextrose Agar (PDA) Media

Dextrose	:	1 gm
KH_2PO_4	:	3 gm
$NaNO_3$	:	0.1 gm
KCl	:	0.1 gm
$MgSO_4$	:	0.1 gm
Agar	:	15 gm
Distilled water	:	1000 ml

3.7 Plant analysis

3.7.1 Protein (%)

It was determined by Kjeldahl's method given by Jackson (1973).

3.7.2 Oil (%)

It was determined by using Soxhlet's apparatus method by Piper (1966).

3.7.3 Ascorbic acid

Ascorbic acid was determined by Rapid titration method given by Ranganna (1987).

3.8 Yield studies

The yield was recorded from farmers of different crops according to location of Nagpur district.

Chapter IV

RESULTS AND DISCUSSION

The results of the present investigation entitled, "EFFECT OF ORGANIC INPUTS ON SOIL PROPERTIES, YIELD AND QUALITY OF DIFFERENT CROPS UNDER CERTIFIED ORGANIC FARMS IN NAGPUR DISTRICT" are tabulated and discussed under following appropriate heads.

4.1 Properties of soil as influenced by organic sources.

4.2 Fertility status of soil after harvest of crop.

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4.1 Properties of soil as influenced by organic sources

4.1.1 Soil pH (Soil reaction)

The pH (soil reaction) is considered one of the most important characteristics of soils because of its intrinsic function in various phases of soil development, its direct effect on micro-biological activities, its role in deciding availability and uptake of various plant nutrients and its intrinsic relationship with other soil constituent determine by chemical analysis. Result revealed that Soil pH was influenced by the continuous incorporation of various organic nutrients (solid or liquid) sources for various crops presented at different locations since 7 to 17 years. The value of soil pH varied from 7.02 to 8.12 under different sources of organics applied at different locations which indicate the soil of study area was neutral to moderately alkaline in soil reaction (table 2).

Table No. 2 Effect of various organic sources on soil pH and EC of soil at harvest of different crops

Location	Crops		Source	Soil pH Soil :water ratio (1:2.5)	EC, dS m^{-1}
Selu	1)	Mandarin [e]	Organic	7.69	0.292
	2)	Mandarin	Fertilizer	7.98	0.279
	3)	Tomato [e]	Organic	7.85	0.315
	4)	Tomato	Fertilizer	8.03	0.289
Kalmeshwar	1)	Fenugreek+ Spinach [d]	Organic	7.74	0.276
	2)	Inorganic	Fertilizer	8.12	0.312
Gangner	1)	Mandarin [e]	Organic	7.65	0.311
	2)	Mandarin	Fertilizer	7.85	0.297
	3)	Rice [b]	Organic	7.02	0.278
	4)	Soybean [d]	Organic	7.35	0.287
	5)	Inorganic	Fertilizer	7.78	0.240
Saoner	1)	Pigeonpea [c]	Organic	7.72	0.257
	2)	Pigeonpea	Fertilizer	7.94	0.267
	3)	Wheat [a]	Organic	7.47	0.326
	4)	Sweet orange [e]	Organic	7.89	0.295
	5)	Inorganic	Fertilizer	8.01	0.263
Chacher	1)	Rice [b]	Organic	7.10	0.293
	2)	Rice	Fertilizer	7.25	0.281
	3)	Mandarin [e]	Organic	7.45	0.312
	4)	Soybean [c]	Organic	7.35	0.243
	5)	Inorganic	Fertilizer	7.49	0.249
Chinchbhavan	1)	Mandarin [e]	Organic	7.68	0.308
	2)	Sorghum (Maldandi) [b]	Organic	7.42	0.254
	3)	Onion [a]	Organic	7.29	0.245
	4)	Inorganic	Fertilizer	7.85	0.303

a = 10 t FYM ha^{-1}, ***b*** = 5 t FYM ha^{-1}, ***c*** = 2.5 t FYM ha^{-1},
d = Jivamrut @ 500 lit ha^{-1}, ***e*** = Ghanjivamrut @ 500 kg ha^{-1}.

Results revealed that the incorporation of organic sources in term of solid and liquid continuously for 7 to 17 years, reduced the soil pH in the locations could be ascribed to the acidifying effect of nitrogen and organic acid produced during the decomposition of organic

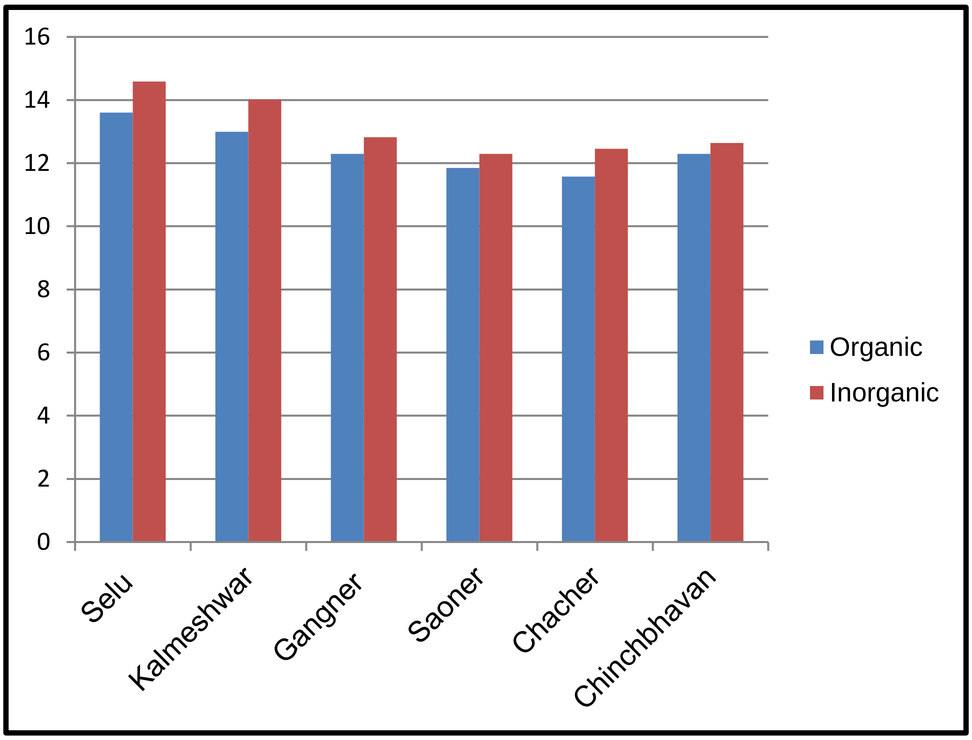

Fig. 1: Soil pH influenced by organic inputs

materials. Similar results were coated by Singh *et al.* (2015), that the application of pressmud were found more effective than application of FYM in reducing soil pH in the soil after the harvest of rice and wheat. Also Sihi *et al.* (2017) observed that, soil pH was 0.5 unit lower in organic fields as compared to conventional fields and associated with the formation of humus and organic acids on decomposition.

Soil pH was observed in between 7.69 to 8.03, 7.74 to 8.12, 7.02 to 7.85, 7.47 to 8.01, 7.01 to 7.49 and 7.29 to 7.85 with the use of organic sources like ghanjivamrut, jivamrut and FYM applied at Selu, Kalmeshwar, Gangner, Saoner, Chacher and Chinchbhavan, respectively (table-2), which indicates the value of pH decreased with increasing the quantity of organic sources applied. Ramani *et al.* (2016) reported that numerically lower value of soil pH 7.63 was found under 25 % N through BC : VC : CC + green sesbania mulch 5 t ha^{-1} and higher value of soil pH 8.02 was recorded under 50 % N through BC : VC : CC + sugarcane trash @ 2 t ha^{-1}.

4.1.2. Electrical Conductivity (dS m^{-1})

The data of electrical conductivity of soil is presented in table-2. Electrical conductivity gives an insight about the presence of soluble salts and used as one of the criteria to differentiate between saline and non-saline soil. In all locations, there is no much variation in EC of soil with the application of various organic sources or inorganic fertilizer alone.

The values of electrical conductivity of soil ranged between 0.215 to 0.316 dS m^{-1} with the use of organic and inorganic fertilizers among the locations. The lowest EC of soil was recorded 0.215 dS m^{-1} with the use of ghanjivamrut @ 500 lit ha^{-1} at Saoner location where as maximum EC of soil was recorded 0.316 dS m^{-1} with the application of inorganic fertilizer at the Gangner location. The EC of soil remained almost unchanged by the action of organic sources which is under permissible limit (< 1 dSm^{-1}). Similar observation were repeated by Rathod *et at.* (2003) that organic inputs in the form of FYM at 5 t ha^{-1}

lowers electrical conductivity of the soil. Also Mponya *et al*. (2014) informed that the EC of soil recorded 0.89 dS m^{-1} under RDF where as 0.76 dS m^{-1} with application of vermicompost @ 15 t ha^{-1}.

4.1.3. Organic carbon (g kg^{-1})

The importance of soil organic carbon (SOC) in sustaining soil productivity is known since the dawn of human civilization. Soil organic carbon is of prime importance for various plant nutrient cycles and influence soil colour, water retention, bulk density, susceptibility to erosion and soil structure. It can be improved under integrated nutrient management and balanced amount of organic inputs.

The results obtained of soil organic carbon as influenced by various organic source is presented in table-3. The soil organic varied from 4.28 to 7.81 g kg^{-1} in the field treated with various organic sources and chemical fertilizers alone. When the continuous use of ghanjivamrut @ 500 kg ha^{-1} to tomato crop from 10 years at Selu locations recorded the highest organic carbon content in soil (7.81 g kg^{-1}) which may be attributed to highest contribution of organic carbon to the soil in the form of solid source.

The observed values of organic carbon of soil comes under the categories of medium to moderately high at the locations of Selu, Gangner, Saoner, Chacher and Chinchbhavan, respectively, when they are using the ghanjivamrut @ 500 kg ha^{-1}, jivamrut @ 500 lit. ha^{-1} and FYM @ 2.5 to 10 t ha^{-1} since 7 to 17 years.

The application of organic inputs from 7 to 17 years resulted an increased organic carbon content of soil by 17.06, 33.73, 46.48, 17.35, 12.75 and 30.94 per cent at Selu, Kalmeshwar, Gangner, Saoner, Chacher and Chinchbhavan, respectively over the use of inorganic fertilizer alone. Improvement in soil organic carbon status with continuously received of different organic inputs, this might have been due to incorporation of organic amendment in terms of solid and liquid balanced amount since 7-17 years and also its rapid mineralization under temperate conditions. This is in accordance with the result of

Yadav *et al.,* (2009) who reported that FYM application increases organic carbon content in soil.

Table No. 3 Effect of various organic sources on chemical properties of soil at harvest of different crops

Location		Crops	Source	OC (g kg^{-1})	% increased / decreased over inorganic	$CaCO_3$ (%)
Selu	1)	Mandarin [e]	Organic	6.79	+17.06	3.15
	2)	Mandarin	Fertilizer	5.80	-	4.23
	3)	Tomato [e]	Organic	7.81	+6.18	4.10
	4)	Tomato	Fertilizer	5.98	-	4.35
Kalmeshwar	1)	Fenugreek+ Spinach [d]	Organic	7.11	+33.73	2.97
	2)	Inorganic	Fertilizer	5.84	-	3.93
Gangner	1)	Mandarin [e]	Organic	6.87	+33.91	4.05
	2)	Mandarin	Fertilizer	5.13	-	4.45
	3)	Rice [b]	Organic	4.96	+2.47	3.05
	4)	Soybean [d]	Organic	7.09	+46.48	2.90
	5)	Inorganic	Fertilizer	4.84		4.13
Saoner	1)	Pigeonpea [c]	Organic	6.39	+4.38	2.80
	2)	Pigeonpea	Fertilizer	6.11	-	3.10
	3)	Wheat [a]	Organic	6.58	+24.10	3.01
	4)	Sweet orange [e]	Organic	6.22	+17.35	2.95
	5)	Inorganic	Fertilizer	5.30	-	3.15
Chacher	1)	Rice [b]	Organic	4.58	+7.00	3.10
	2)	Rice	Fertilizer	4.28	-	3.10
	3)	Mandarin [e]	Organic	6.29	+8.44	3.30
	4)	Soybean [c]	Organic	6.56	+12.75	2.95
	5)	Inorganic	Fertilizer	5.80	-	3.15
Chinchbhavan	1)	Mandarin [e]	Organic	6.57	+20.32	3.67
	2)	Sorghum (Maldandi) [b]	Organic	6.09	+11.53	3.29
	3)	Onion [a]	Organic	7.15	+30.94	3.07
	4)	Inorganic	Fertilizer	5.46	-	4.27

a = 10 t FYM ha^{-1}, ***b*** = 5 t FYM ha^{-1}, ***c*** = 2.5 t FYM ha^{-1},
d = Jivamrut @ 500 lit ha^{-1}, ***e*** = Ghanjivamrut @ 500 kg ha^{-1}.

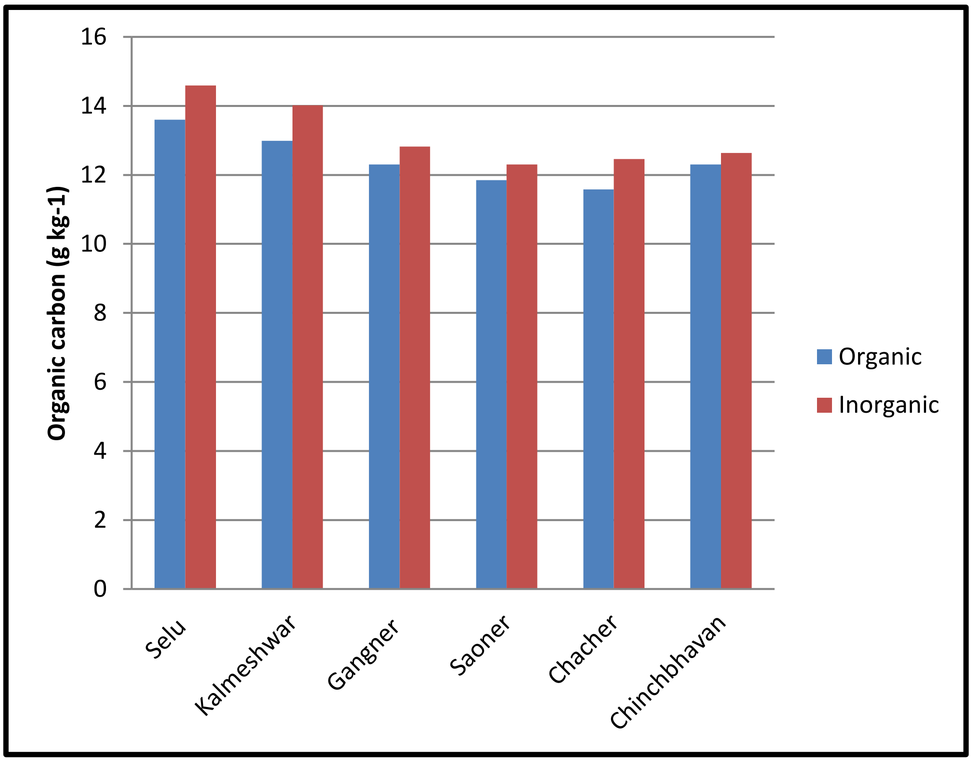

Fig. 2: Effect of organic inputs on soil organic carbon

Similarly also Chhibba (2010) reported that, the incorporation of crop residues and FYM alone or in combination with green manuring significantly increases the organic carbon content. Also Parmar and Thakur (2017) reported that, largest increase for soil organic carbon (1.07 %) was recorded under organic practice at top layer.

4.1.4. Calcium Carbonate (%)

The results of $CaCO_3$ content in soil is presented in table-3. The calcium carbonate is one of the important property of soil which is associated with the nutrient availability, effect of organic carbon, soil reaction and availability of micronutrients of soil and exchangeable cations. The value of calcium carbonate content in soil varied from 2.80 to 4.45 % under the application of organic and inorganic inputs. The value of calcium carbonate did not have much more difference in all the locations. The different locations viz. Selu, Kalmeshwar, Gangner, Saoner, Chacher and Chinchbhavan recorded the values of calcium carbonate in soil between 3.15 to 4.13, 2.97 to 3.93, 2.90 to 4.45, 2.80 to 3.15, 2.95 to 3.30 and 3.07 to 4.27 per cent, respectively, when the field applied organic or inorganic fertilizer alone. These values of calcium carbonate ranges under the moderately calcareous in nature.

Similar findings were reported by Sleutel *et al.* (2006) that, long-term applications of animal manure increase SOM and decreases calcium carbonate content in two ways by adding OM contained in the manure and by increased OM in crop residues due to higher crop yields. Also Kharche (2013) reported that the significant reduction in free $CaCO_3$ could be attributed to considerable amount of biomass added to the soil due to long-term cultivation and organic matter applied through conjunctive use treatments. The reduction in $CaCO_3$ might be due to organic acids released during the decomposition of organic materials which react with $CaCO_3$ to release CO_2 thereby reducing $CaCO_3$ content of the soil.

4.2 Fertility status of soil after harvest of crops

4.2.1 Available nitrogen of soil (kg ha^{-1})

The available nitrogen content in soil after harvest of crop is presented in table-4. The available nitrogen of soil is one of the important parameter in substantial agricultural production and soil fertility. The data indicated that, the available nitrogen in soil varied from 189.00 to 349.44 kg ha^{-1}. The observed value of available N content of soil comes under the categories of low to medium in range. When field treated with the continuous use of organic nutrient source in terms of solids or liquid from 7-17 years, increased the availability of nitrogen content of soil as compared to inorganic fertilizer.

The application of organic inputs from 7 to 17 years resulted in maximum available N content of soil by 2.08 to 44.18 per cent over the application of inorganic fertilizer alone. The maximum increase of available N (44.18 %) is recorded in soybean crop where Jivamrut @ 500 lit ha^{-1} was applied. The increase in available N content of soil might be attributed to the more N fixation in soil on account of higher microbial population, leaving to better mineralization of organic N with other nutrient application.

Among the organic nutrient sources, the ghanjivamrut, jivamrut and FYM performed better possibly because of higher nutrient status and good C:N ratio increase in available N with organics is attributes to its direct addition through organics as ghanjivamrut, FYM contributes good amount of nutrients which was released on mineralization with time. The fertility status of soil might have helped in the mineralization of soil N leading to its higher build up with use of balanced organic inputs. Similar results were reported by Balpande *et al.* (2013) that available nitrogen status was higher in manurial liquids, it was significantly higher in vermiwash followed by panchganvya and amrutpani. Also Sharma *et al*., (2013) observed that, available N status in soil increased with application of organic sources along with fertilizers.

Table No.4 Effect of organic sources on fertility status of soil after harvest of different crops

Location		Crops	Source	Available N (kg ha^{-1})	%increased / decreased over inorganic	Available P (kg ha^{-1})	%increased / decreased over inorganic
Selu	1)	Mandarin [e]	Organic	301.50	+15.77	19.20	-14.77
	2)	Mandarin	Fertilizer	260.42	-	22.60	-
	3)	Tomato [e]	Organic	349.44	+31.90	21.20	-25.97
	4)	Tomato	Fertilizer	264.91	-	28.64	-
Kalmeshwar	1)	Fenugreek + Spinach [d]	Organic	319.44	+22.39	15.26	-24.94
	2)	Inorganic	Fertilizer	261.00	-	20.34	-
Gangner	1)	Mandarin [e]	Organic	305.32	+33.03	18.98	-22.08
	2)	Mandarin	Fertilizer	229.50	-	24.36	-
	3)	Rice [b]	Organic	220.50	+2.08	20.58	-22.22
	4)	Soybean [d]	Organic	313.60	+45.18	22.34	-15.64
	5)	Inorganic	Fertilizer	216.00	-	26.46	-
Saoner	1)	Pigeonpea [c]	Organic	282.87	+3.27	20.74	-25.23
	2)	Pigeonpea	Fertilizer	273.89	-	27.74	-
	3)	Wheat [a]	Organic	291.20	+22.09	19.35	-35.50
	4)	Sweet orange [e]	Organic	277.76	+16.46	18.77	-37.43
	5)	Inorganic	Fertilizer	238.50	-	30.00	-
Chacher	1)	Rice [b]	Organic	202.50	+7.14	21.64	-21.11
	2)	Rice	Fertilizer	189.00	-	27.43	-
	3)	Mandarin [e]	Organic	279.00	+6.89	18.36	-24.22
	4)	Soybean [c]	Organic	292.50	+12.06	20.24	-16.40
	5)	Inorganic	Fertilizer	261.00	-	24.23	-
Chinchbhavan	1)	Mandarin [e]	Organic	292.50	+20.37	20.17	-11.76
	2)	Sorghum (Maldandi) [b]	Organic	270.00	+11.11	16.27	-28.82
	3)	Onion [a]	Organic	318.08	+30.89	19.94	-12.77
	4)	Inorganic	Fertilizer	243.00	-	22.86	-

a = 10 t FYM ha^{-1}, ***b*** = 5 t FYM ha^{-1}, ***c*** = 2.5 t FYM ha^{-1},
d = Jivamrut @ 500 lit ha^{-1}, ***e*** = Ghanjivamrut @ 500 kg ha^{-1}.

4.2.2 Available phosphorus of soil (kg ha^{-1})

The available phosphorus content of soil after harvest of crops varied from15.26 to 30.00 kg ha^{-1} under the application of organic and inorganic fertilizers. The value of available P content of soil comes under the categories of medium to high range. All the locations found decreased the availability of P when the use organic sources over the inorganic sources. Available P also noted higher value 30.0 kg ha^{-1} at Saoner location under the application of inorganic fertilizers.

In the present study, there was decreased in available phosphorous content in soil with the use of organic inputs upto 37-43 per cent over the application of chemical fertilizers alone. Balanced inorganic fertilizer and crop residues helps in increasing the phosphorous content in solution and solubelization of native soil phosphorous. Chesti and Ali (2012) revealed that, soil available P recorded an increased between 16 to 24 per cent due to application of 30 to 60 kg P_2O_5 ha^{-1}, respectively.

In Selu the available phosphorus was recorded between 15.26 to 22.60 kg ha^{-1}. Similarly the available phosphorus was recorded between19.20 to 26.34, 18.98 to 26.46, 18.77 to 30.00, 18.36 to 27.43 and 16.27 to 22.86 kg ha^{-1} at Selu, Kalmeshwar, Gangner, Saoner, Chacher and Chinchbhavan location respectively. From the results it is showed that, the application of organic inputs resulted the decreased available P content in soil over the quantity applied of inorganic fertilizer at all locations.

The build-up of available P with the application of inorganic fertilizer and crop residue was ascribed to the release of organic acid, during decomposition which in turn helped in releasing native phosphorous through solubalizing action of the acids and thus reduces the P fixing capacity of soil which ultimately helps in release of sufficient quantity of plant available phosphorous (Sharma and Subehia, 2014). Srilata and Sharma (2015) reported that, continuous use of organic manure coupled with fertilization had build up of available phosphorous in the treatment where it was applied and slightly depletion those, where it was not applied. P status of soil increased with increasing level of fertilizers due to lower utilization of P by crop from applied sources. Datt *et al.*2003 and Das *et al.* (2017)

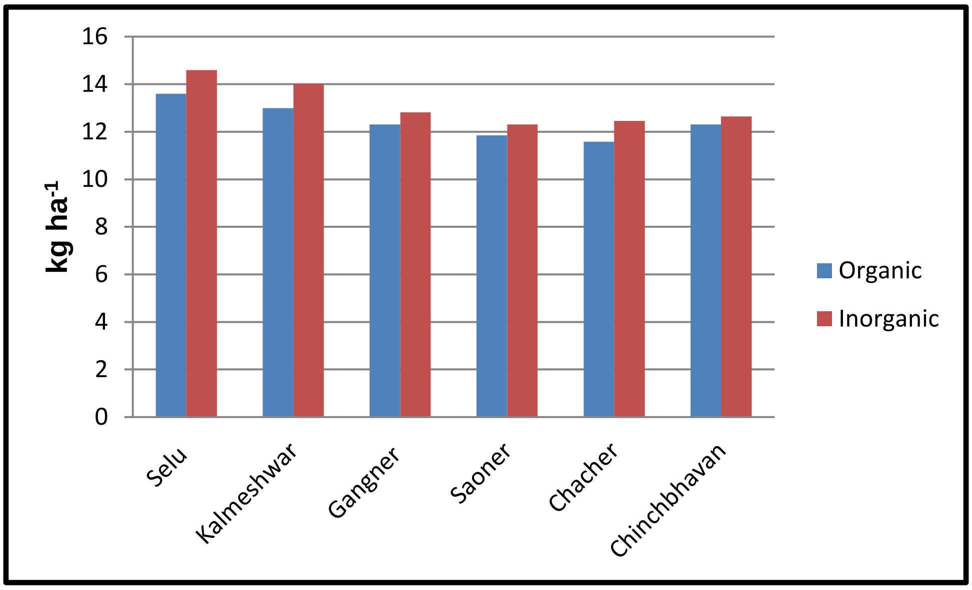

Fig. 3: Available N of soil as influenced by organic inputs

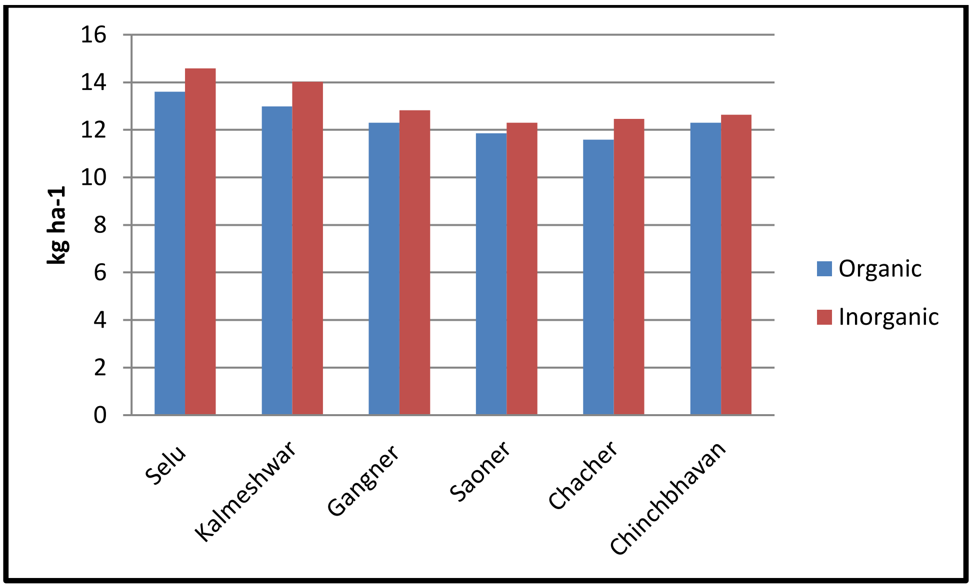

Fig. 4: Available P of soil as influenced by organic inputs

observed that, soil available P was significantly higher under inorganic than control but remained at par with organic and INF. Soil available P under inorganic, organic and INF were 89.4, 85.9 and 82.3 % higher than those observed under control.

4.2.3 Available potassium of soil (kg ha^{-1})

The data on available potassium in soil after harvest of crop is presented in table-5. The application of organic and inorganic fertilizers since 7-17 years to different crops which influenced the value of soil available K. The magnitude of available K ranged from 337.62 to 431.06 kg ha^{-1}. The minimum available K was observed in Chacher at soybean field under the use of FYM @ 2.5 t ha^{-1} and maximum of 431.06 kg ha^{-1} with application of inorganic fertilizer at Chinchbhavan location. The value of available potassium in soil was found very high in range in the present study.

The data further revealed that, the application of inorganic fertilizers alone (NPK) recorded an increased in available K content in soil by 1.26 to 11.95 per cent. The increasing available K in soil due to addition of organic sources may be ascribed to the reduction of K fixation and released of K due to interaction of organic material with clays besides the direct K addition in the soil (Subehia and Sepehya, 2012)

The available K content was observed in the range of 382.61 to 430.2, 378.16 to 405.19, 385.13 to 428.93, 356.11 to 421.32, 337.62 to 381.45 and 379.51 to 431.06 kg ha^{-1} at location of Selu, Kalmeshwar, Gangner, Saoner, Chacher and Chinchbhavan, respectively with the continuous use of organic and inorganic fertilizers. Hampton *et al*. (2011) reported that, soil K concentrations were higher in the organic amendment treatments than the control.

Insufficient addition of K through fertilizers, pressmud and vermicompost, and consequently higher removal by crops might be the possible reason of decrease in K availability in soil (Gogoi *et al.,* 2015).

Table No. 5 Effect of organic sources on fertility status of soil after harvest of different crops.

Location	Crops		Source	Available K (kg ha^{-1})	Increased / decreased % over inorganic	Available S (mg kg^{-1})
Selu	1)	Mandarin [e]	Organic	398.32	-4.08	13.32
	2)	Mandarin	Fertilizer	415.28	-	14.57
	3)	Tomato [e]	Organic	382.61	-11.02	13.89
	4)	Tomato	Fertilizer	430.02		14.61
Kalmeshwar	1)	Fenugreek+ Spinach [d]	Organic	378.16	-6.67	12.99
	2)	Inorganic	Fertilizer	405.19	-	14.02
Gangner	1)	Mandarin [e]	Organic	405.38	-5.49	12.69
	2)	Mandarin	Fertilizer	428.93	-	12.83
	3)	Rice [b]	Organic	394.24	-6.03	11.93
	4)	Soybean [d]	Organic	385.13	-8.20	12.29
	5)	Inorganic	Fertilizer	419.56	-	12.81
Saoner	1)	Pigeonpea [c]	Organic	394.69	-6.32	11.63
	2)	Pigeonpea	Fertilizer	421.32	-	12.19
	3)	Wheat [a]	Organic	403.14	+1.26	11.92
	4)	Sweet orange [e]	Organic	356.11	-10.65	12.02
	5)	Inorganic	Fertilizer	398.57	-	12.42
Chacher	1)	Rice [b]	Organic	375.32	-1.92	11.03
	2)	Rice	Fertilizer	381.45	-	12.07
	3)	Mandarin [e]	Organic	351.92	-2.02	11.56
	4)	Soybean [c]	Organic	337.62	-6.00	12.15
	5)	Inorganic	Fertilizer	359.18	-	12.86
Chinchbhavan	1)	Mandarin [e]	Organic	409.12	-5.08	12.69
	2)	Sorghum (Maldandi) [b]	Organic	401.33	-6.89	11.14
	3)	Onion [a]	Organic	379.51	-11.95	13.08
	4)	Inorganic	Fertilizer	431.06	-	12.64

a = 10 t FYM ha^{-1}, ***b*** = 5 t FYM ha^{-1}, ***c*** = 2.5 t FYM ha^{-1},
d = Jivamrut @ 500 lit ha^{-1}, ***e*** = Ghanjivamrut @ 500 kg ha^{-1}.

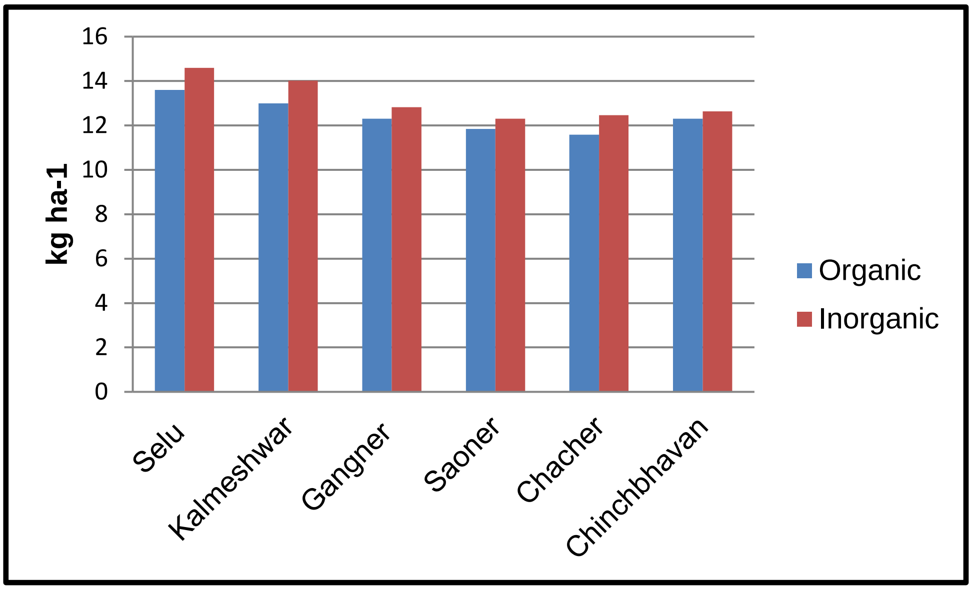

Fig. 5: Available K of soil as influenced by organic inputs

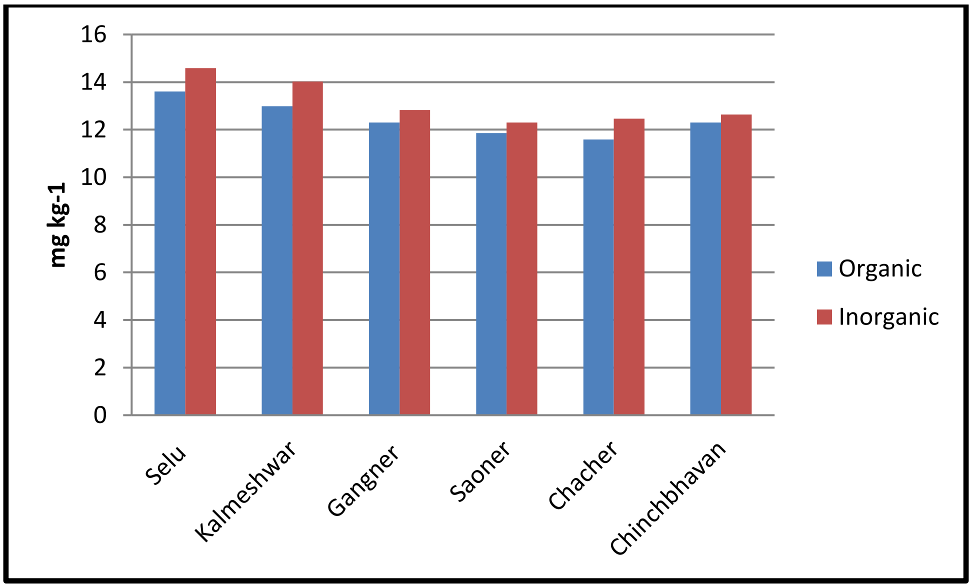

Fig. 6: Available S of soil as influenced by organic inputs

4.2.4 Available sulphur of soil (kg ha^{-1})

Sulphur is considered as fourth major nutrient for plant growth. The data regarding the available sulphur in the soil is presented in table 4. The available sulphur ranged from 11.03 to 14.61 mg kg^{-1} i.e. low to moderately high (table 5). The variation of available S was observed between the continuous use of organic sources and inorganic inputs applied. The higher amount of available S was recorded due to application of inorganic fertilizer than the use of organic source alone at Saoner, Kalmeshwar, Chacher, Selu and Chinchbhavan locations. It may be due to inorganic fertilizer containing sulphur and incorporation of organic carbon content in soil. Addition of FYM contributed appreciable amount of Sulphur at 0.17 %, which resulted in increased S content of soil.

At location of Selu, Kalmeshwar, Gangner, Saoner, Chacher and Chinchbhavan observed the sulphur content in the range of 13.32 to 14.61, 12.99 to 14.02, 11.93 to 12.83, 11.62 to 12.19, 11.03 to 12.86 and 11.14 to13.08 kg ha^{-1}, respectively among the field treated with organic source and chemical fertilizer alone. The increased in available sulphur might be due to addition of 18:18:10 and 18:46 which content about 18 kg N and 46 kg P. Patel and Das (2009) reported that, total S (0.32 %) was obtained with sample of FYM. Rahile (2014) reported soil available S content between 9.95 to 15.15 kg ha^{-1} with application of organic source viz. amritpani, jivamrut, ghanjivamrut and inorganic fertilizer alone.

Sharma and Subehia (2014) reported that, an increased the available sulphur 10.8 under no use of fertilizer to a maximum 22.7 kg ha^{-1} with use of 50 % NPK through FYM + 50 % NPK through chemical fertilizer.

4.3 Micronutrients status in soils as influenced by organic sources

The term micronutrients denote the elements, which are essential for the plant but are required in small quantity. In view of the fact that pH, ESP and $CaCO_3$ controls the availability of micronutrient in the shrink-swell soils. Yadav and Meena, (2009) reported that, the soil properties (silt, clay, organic carbon, CEC, free $CaCO_3$ and soil pH) influenced the availability of micronutrients. Availability of micronutrients increased significantly with increase in organic carbon and clay content in it, due to formation of chelate complexes. On the other hand, the availability of micronutrients as significantly reduced with increases in $CaCO_3$ and soil pH. The addition of organic matter encourages the availability of micronutrients in soil. The data in respect of DTPA extractable micro-nutrients (Zn, Fe, Mn and Cu) in soil after harvest of crop is depicted in table-6.

4.3.1 Concentration of Zn in Soil (mg kg^{-1})

The results revealed that the status of DTPA extractable Zn ranged between 0.48 to 0.72 mg kg^{-1} when the application of organic sources and chemical fertilizer alone among the different locations. The Zn status of these locations comes under low to medium in range.

The highest availability of DTPA extractable Zn (0.72 mg kg^{-1}) was found at Selu in tomato field where ghanjivamrut @ 500 kg ha^{-1} applied. The application of organic inputs recorded increased availability of DTPA extractable Zn over the application of fertilizer alone.

The locations viz. Selu, Kalmeshwar, Gangner, Saoner, Chacher and Chinchbhavan, the value of Zn in soil was observed between 0.58 to 0.67, 0.52 to 0.62, 0.51 to 0.72, 0.51 to 0.63, 0.53 to 0.64 and 0.53 to 0.64 mg kg^{-1}, respectively among the field received the solid or liquid organic source or chemical fertilizer alone.

Wide variation in proportion of Zn deficit soil sample within locations which is related with soil texture, pH, organic matter of soil. Panwar *et al.* (2010) reported that, the organic matter treatment had significantly greater Fe, Mn, Zn, and Cu content than inorganic treatment.

Table No. 6 Effect of various organic sources on micronutrients status of soil at harvest of different crops

Location	Crops		Source	Zn (mg kg^{-1})	Fe (mg kg^{-1})	Mn (mg kg^{-1})	Cu (mg kg^{-1})
Selu	1)	Mandarin ^{e}	Organic	0.59	7.25	6.54	3.23
	2)	Mandarin	Fertilizer	0.58	6.33	4.93	4.32
	3)	Tomato ^{e}	Organic	0.72	7.89	7.81	3.51
	4)	Tomato	Fertilizer	0.67	7.63	6.23	4.27
Kalmeshwar	1)	Fenugreek+ Spinach ^{d}	Organic	0.62	8.07	6.31	3.71
	2)	Inorganic	Fertilizer	0.52	7.86	4.85	2.81
Gangner	1)	Mandarin ^{e}	Organic	0.63	8.11	6.91	4.41
	2)	Mandarin	Fertilizer	0.72	8.05	5.53	4.51
	3)	Rice ^{b}	Organic	0.67	7.34	6.21	2.67
	4)	Soybean ^{d}	Organic	0.61	7.74	6.73	2.92
	5)	Inorganic	Fertilizer	0.51	6.97	5.43	2.65
Saoner	1)	Pigeonpea ^{c}	Organic	0.53	8.21	6.47	3.56
	2)	Pigeonpea	Fertilizer	0.62	8.13	5.43	2.92
	3)	Wheat ^{a}	Organic	0.51	7.61	7.83	3.42
	4)	Sweet orange ^{e}	Organic	0.61	7.92	5.64	3.59
	5)	Inorganic	Fertilizer	0.63	7.33	6.43	3.99
Chacher	1)	Rice ^{b}	Organic	0.58	7.46	4.32	3.99
	2)	Rice	Fertilizer	0.64	7.63	4.93	3.91
	3)	Mandarin ^{e}	Organic	0.64	7.99	6.68	3.53
	4)	Soybean ^{c}	Organic	0.53	7.51	6.53	2.82
	5)	Inorganic	Fertilizer	0.63	6.87	4.21	3.53
Chinchbhavan	1)	Mandarin ^{e}	Organic	0.64	7.89	6.68	3.53
	2)	Sorghum (Maldandi) ^{b}	Organic	0.53	7.64	6.54	3.86
	3)	Onion ^{a}	Organic	0.57	8.82	7.78	3.78
	4)	Inorganic	Fertilizer	0.48	6.38	5.21	3.73

a = 10 t FYM ha^{-1}, ***b*** = 5 t FYM ha^{-1}, ***c*** = 2.5 t FYM ha^{-1},
d = Jivamrut @ 500 lit ha^{-1}, ***e*** = Ghanjivamrut @ 500 kg ha^{-1}.

Yadav *et al*. (2013) reported that, the application of various organic sources, increased significantly the DTPA-Zn in soil over control. DTPA-Zn in soil was recorded to the tune of 0.67, 0.74 and 0.62 mg kg^{-1} with application of 10 t FYM and 5 t ha^{-1}, respectively whereas control recorded 0.57 mg kg^{-1}. Moharana *et al.* (2017) also reported that, available Zn concentrations varied greatly amongst the different treatments. Application of FYM significantly increased available Zn concentration. Significant increase in available Zn in surface soil (0–15 cm) was maintained in plots receiving FYM (1.36 mg kg^{-1}) and integrated use of FYM+NPK fertilizer (1.54 mg kg^{-1}) over NPK treated (1.24 mg kg^{-1}) and unfertilized control plots (0.99 mg kg^{-1}). However, increases in available Zn in sub-surface soil (15–30 cm) were observed only under plots receiving FYM and FYM+NPK fertilizer over unfertilized control.

4.3.2 Concentration of Fe in soil (mg kg^{-1})

The data of Fe status in soil is presented in table-6. The DTPA extractable Fe status in soil varied from 6.33 to 8.82 mg kg^{-1} among the all locations, which represent the sufficient quantity of iron present in soil and medium in range, as the critical limit reported 4.5 mg kg^{-1}.The organic inputs or the application through different inorganic sources cause more CO_2 resulting the greater accumulation of available Fe. It is apparent that availability of Fe increased with increasing in organic matter content in the soils and increased the solubility of Fe. The DTPA extractable iron status of all the locations found medium in range 4.5 to 18.0 mg kg^{-1} as stated by Patil *et al.* 2004.

The value of iron in soil was observed in between 7.25 to 6.33, 7.86 to 7.86, 6.97 to 8.11, 7.33 to 8.21, 6.87 to 7.99 and 6.38 to 8.28 mg kg^{-1} in location of Selu, Kalmeshwar, Gangner, Saoner, Chacher and Chinchbhavan when they applied various organic sources in terms of solid/ liquid that was Ghaniavamrut @ 500 kg ha^{-1}, Jivamrut 500 lit ha^{-1} and FYM @ 2.5 to 10 t ha^{-1} and the different doses of chemical fertilizer, which comes under medium range.

Calero *et al.* (2012) reported that organic soils had a slightly lower pH than in conventional soils, and organic amendments improve the availability to plants of several micronutrients (Fe, Mn, Zn, etc.) in the organic plots. Jat and Singh (2017) observed that, the Fe content was found to be higher in the treatments receiving fertilizers with FYM. Also Moharana *et al.* (2017) showed that, increase in available Fe in surface soil was 36.9 and 39.9 per cent in FYM and FYM+NPK fertilizer treated plots over control, respectively.

4.3.3 Concentration of Mn in soil (mg kg^{-1})

The data in respect of Mn in soil is presented in table-6. The DTPA extractable Mn status in soil varied from 4.21 to 7.83 mg kg^{-1} among all locations, which represent the high quantity of Mn present in soil as the critical limit as 2.0 mg kg^{-1}. Kharche (2013) reported that, the application of FYM significantly increased availability of micro-nutrient over rest of treatments probably due to decomposition of FYM.

The value of magnese in soil was observed in between 4.93 to 7.81, 4.85 to 6.31, 5.43 to 6.91, 5.43 to 7.83, 4.21 to 6.68 and 5.21 to 7.78 mg kg^{-1} in location of Selu, Kalmeshwar, Gangner, Saoner, Chacher and Chinchbhavan, respectively when they applied various organic sources of Ghanjivamrut @ 500 kg ha^{-1}, Jivamrut 500 lit ha^{-1} and FYM @ 2.5 to 10 t ha^{-1} and the different doses of chemical fertilizer. Hampton *et al.* (2011) revealed that long term application of organic amendments improve micronutrients concentrations of soil.

4.3.4 Concentration of Cu in soil (mg kg^{-1})

The DTPA extractable Cu status in soil varied from 2.65 to 4.51 mg kg^{-1} among the all locations (table-9) which represent the high quantity of Cu present in soil.

The value of copper in soil varied from 3.23 to 4.32, 2.81 to 3.71, 2.65 to 4.51, 2.29 to 3.99, 2.82 to 3.91 and 2.73 to 3.86 mg kg^{-1} in location of Selu, Kalmeshwar, Gangner, Saoner, Chacher and Chinchbhavan, respectively when they applied various organic sources of Ghanjivamrut @ 500 kg ha^{-1}, Jivamrut 500 lit ha^{-1} and FYM @ 2.5 to 10 t ha^{-1} and the different doses of chemical fertilizer, which comes under high range. Muzaffar *et al.* (2013) reported that, application of bioferlizer 80 g tree^{-1}, vermicompost 20 kg tree^{-1}, FYM 20 kg tree^{-1} and green manure of sunhemp to mandarin crop and resulted in significantly availability of copper (3.25 ppm) and magnese (61.95 ppm).

4.4 Influence of organic inputs on microbial population of soils

The data pertaining to microbial population of bacteria, fungi and actinomycetes are presented in table-7. Bacterial population showed higher as compared to fungi and actinomycetes in the organic and inorganic cultivation.

The range of bacterial count observed from 16.25 to 22.50 X 10^7 cfu g^{-1} at selected location. The bacteria count was increased by the application of organic inputs. The higher level of NPK produced favourable influence on bacteria. These results are in line with the findings of Deshpande *et al.* (2010) reported higher population of soil micro-flora *viz.,* bacteria, fungi, actinomycetes, free living nitrogen fixers and PSB at different growth stages of both green gram and *rabi* sorghum with combined application of organic manures along with panchagavya.

The fungal population was recorded upto 16.25 X 10^5 cfu g^{-1} in organic and inorganic field. Application of organic material to field was found increasing in the fungal count over the application of inorganic fertilizers. The fungal count was recorded between 10.75 to 16.25 X 10^5 cfu g^{-1}. The maximum fungal count was found in onion field when FYM @10 t ha^{-1} was applied. This could be ascribed to the FYM which supplied large amount of readily available carbon, resulting in more diverse and dynamic microbial system than in inorganically fertilized soil.

The actinomycetes count was recorded between 7.25 to 13.75 X 10^5 cfu g^{-1}. Similarly the count of actinomycetes was found more in organic input applied field than the fertilizers applied field. Ingle *et al.* (2014) recorded that, the bacterial, fungal and actinomycetes was 22.5 X 10^7 cfu g^{-1}, 12.50 X 10^4 cfu g^{-1} and 13 X 10^6 cfu g^{-1} respectively in FYM @ 10 t ha^{-1} applied field, where as the count of bacteria, fungi and actinomycetes was 15.5 X 10^7 cfu g^{-1}, 11.25 X 10^4 cfu g^{-1} and 11.75 X

10^6 cfu g^{-1} recorded respectively in 100 % NPK applied field which was less than FYM applied field.

Table No. 7 Effect of various organic sources on microbial count (cfu g^{-1}) of soil

Location		Crops	Source	Bacteria (X 10^7 cfu g^{-1})	Fungi (X 10^5 cfu g^{-1})	Actinomycetes (X 10^5 cfu g^{-1})
Selu	1)	Mandarin *e*	Organic	18.25	13.75	9.00
	2)	Mandarin	Fertilizer	16.50	12.50	7.25
	3)	Tomato *e*	Organic	20.75	13.75	12.75
	4)	Tomato	Fertilizer	18.50	12.50	10.25
Kalmeshwar	1)	Fenugreek+ Spinach *d*	Organic	21.50	14.00	10.50
	2)	Inorganic	Fertilizer	18.75	12.25	11.75
Gangner	1)	Mandarin e	Organic	19.50	13.75	11.00
	2)	Mandarin	Fertilizer	17.25	12.50	9.25
	3)	Rice b	Organic	18.50	13.75	9.75
	4)	Soybean d	Organic	22.25	14.25	10.50
	5)	Inorganic	Fertilizer	17.75	11.75	8.25
Saoner	1)	Pigeonpea c	Organic	22.50	14.00	13.50
	2)	Pigeonpea	Fertilizer	21.25	12.75	11.00
	3)	Wheat a	Organic	21.50	13.50	10.75
	4)	Sweet orange e	Organic	18.75	13.75	9.25
	5)	Inorganic	Fertilizer	16.25	12.75	8.50
Chacher	1)	Rice b	Organic	21.50	12.50	11.75
	2)	Rice	Fertilizer	18.75	10.75	12.50
	3)	Mandarin e	Organic	20.25	13.50	10.00
	4)	Soybean c	Organic	22.00	13.25	12.75
	5)	Inorganic	Fertilizer	18.75	12.75	13.50
Chinchbhavan	1)	Mandarin e	Organic	19.00	13.50	9.25
	2)	Sorghum (Maldandi) b	Organic	18.25	15.00	11.25
	3)	Onion a	Organic	21.75	16.25	9.50
	4)	Inorganic	Fertilizer	17.00	13.75	8.25

a = 10 t FYM ha^{-1}, ***b*** = 5 t FYM ha^{-1}, ***c*** = 2.5 t FYM ha^{-1},
d = Jivamrut @ 500 lit ha^{-1}, ***e*** = Ghanjivamrut @ 500 kg ha^{-1}.

Microbial Count

Plate No. 5: Bacterial count

Plate No. 6: Fungal Count

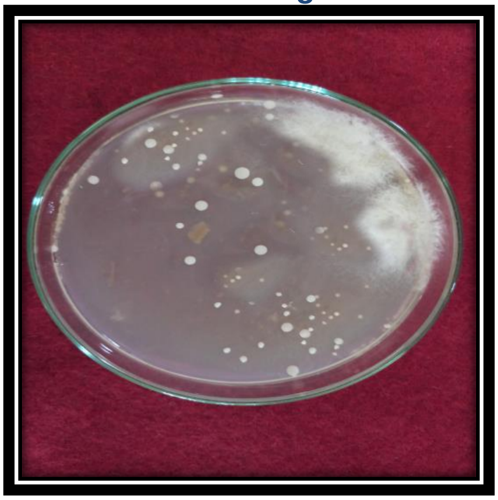

Plate No. 7: Actinomycetes Count

4.5 Yield and quality of crops by application of organic and inorganic sources

4.5.1 Yield of different crops

The data regarding yield of different crops is presented in table-8 as influenced by use of organic and inorganic sources.

4.5.1.1 Mandarin (t ha^{-1})

The yield of mandarin was recorded from 14.5 to 18 t ha^{-1}. The results revealed that, decreased the yield of Nagpur mandarin of 16.0, 17, 15 and 14.5 t ha^{-1} at location of Selu, Gangner, Chacher and Chinchbhavan respectively, when these farmers applied organic input since 7-17 years over the inorganically produced mandarin (18 t ha^{-1}). In all the locations, the yield of Nagpur Mandarin found higher as compared to national average productivity of Nagpur mandarin (10.4 t ha^{-1}) reported by National Horticulture Board, 2015. Also the yield of Nagpur mandarin recorded higher than the average productivity of Nagpur Mandarin in Vidarbha region (5.4 t ha^{-1}) by NHB, 2015.

Surwase *et al.* (2016) studied on twelve Nagpur mandarin orchard represent in Kalmeshwar tahsil of Nagpur district for yield and fruit quality they reported that the yield of Nagpur mandarin 22-28.3 t ha^{-1} found to be high in range.

4.5.1.2 Yield of sweet orange (t ha^{-1})

The yield of sweet orange recorded 14 t ha $^{-1}$ with the application of Ghanjivamrut @ 500 kg ha^{-1} since 9 years, at Saoner location. The yield of sweet orange found also higher as compare to productivity of sweet orange at Vidharbha and national level.

4.5.1.3 Yield of Wheat (t ha^{-1})

The grain yield of wheat is presented in table-8. The grain yield of wheat was 1.9 t ha^{-1} where the continuous use of 10 t FYM ha^{-1} at Saoner. In the present study, trend of grain yield of wheat under organic sources was found more as compared to yield of wheat under conventional farming (1.5 t ha^{-1}) as reported by Ramesh *et al*. (2010).

Table No. 8 Effect of various organic sources and fertilizer on yield (t ha^{-1}) of various crops

Location	Crops	Source	Organic source applied since	Yield (t ha^{-1})
Selu	1) Mandarin [e]	Organic	10 Years	16
	2) Mandarin	Fertilizer		18
	3) Tomato [e]	Organic		25
	4) Tomato	Fertilizer		31
Kalmeshwar	1) Fenugreek+ Spinach [d]	Organic	8 Years	5.2
	2) Inorganic	Fertilizer		-
Gangner	1) Mandarin [e]	Organic	7 Years	17
	2) Mandarin	Fertilizer		19
	3) Rice [b]	Organic		2.4
	4) Soybean [d]	Organic		1.9
	5) Inorganic	Fertilizer		-
Saoner	1) Pigeonpea [c]	Organic	9 Years	1.1
	2) Pigeonpea	Fertilizer		1.4
	3) Wheat [a]	Organic		1.9
	4) Sweet orange [e]	Organic		14
	5) Inorganic	Fertilizer		
Chacher	1) Rice [b]	Organic	13 Year	2.2
	2) Rice	Fertilizer		2.6
	3) Mandarin [e]	Organic		15
	4) Soybean [c]	Organic		1.7
	5) Inorganic	Fertilizer		
Chinchbhavan	1) Mandarin [e]	Organic	17 years	14.5
	2) Sorghum (Maldandi) [b]	Organic		1.2
	3) Onion [a]	Organic		19
	4) Inorganic	Fertilizer		

a = 10 t FYM ha^{-1}, ***b*** = 5 t FYM ha^{-1}, ***c*** = 2.5 t FYM ha^{-1},
d = Jivamrut @ 500 lit ha^{-1}, ***e*** = Ghanjivamrut @ 500 kg ha^{-1}.

Rahile (2014) reported that the grain yield of wheat was noted 2.5 t ha^{-1} with the application of amritpani 500 lit. ha^{-1} + FYM @ 5 t ha^{-1}

at Nandapur location of Nagpur district when the incorporation of solid and liquid organic materials continuously for 6-8 years. Singh *et al.* (2014) reported that, the grain yield of wheat were increased when 120 kg N ha^{-1} + FYM @ 6 t ha^{-1} (5.87 t ha^{-1}) where as grain yield of wheat (5.11 t ha^{-1}) was obtained with 120 kg N ha^{-1} alone under tillage condition. The increase in grain yield of wheat may be ascribed to the better availability of nutrients/ leaving to better minerlization and also stimulate the enzymatic and microorganis activity resulted an increased the yield of wheat.

4.5.1.4 Yield of Pigeonpea (t ha^{-1})

Result indicated that, the application of organic and inorganic sources found sustainable grain yield of pigeonpea (table – 8). The grain yield of pigeonpea varied from 1.1 to 1.4 t ha^{-1} with the management of organic and inorganic sources. The application of chemical fertilizer resulted maximum grain yield of pigeon pea (1.4 t ha^{-1}) as compared to application of organic source. At Saoner recorded grain yield of pigeonpea 1.1 t ha^{-1} when they applied FYM @ 2.5 t ha^{-1} from 9 years.

4.5.1.5 Yield of Rice (t ha^{-1})

The grain yield of Rice as influenced by different organic sources is presented in table-8. The grain yield of rice was recorded between 2.4 and 2.2 t ha^{-1} where the continuous use of 5 t FYM ha^{-1} at Gangner and Chacher locations, respectively. The grain yield of rice recorded more in field where inorganic fertilizer was applied. Similar observations were repeated by Nishan *et al.* (2016) that loss the grain yield of the rice to the tune of 15.25 per cent in organically grown rice over INM treatment.

4.5.1.6 Yield of vegetables (t ha^{-1})

Results indicated that the application of organic and inorganic sources found sustainable yield of vegetable (table – 10). The yield of vegetables varied from 25, 6.2 and 20 t ha^{-1} of tomato, fenugreek +

spinach and onion, respectively with the management of organic sources. In Selu the yield was found more in inorganically produced tomato 29 t ha^{-1}. Chaudhary and Tehlan (2014) observed that, the yield of fenugreek 1.78 and 1.80 t ha^{-1} when the application of poultry manure (1.5 t $acre^{-1}$) and FYM t $acre^{-1}$ whereas 2.07 t ha^{-1} with 15:20:10 NPK $acre^{-1}$. Kumar *et al*. (2014) revealed that, the application of FYM + panchagavya (3%) was found effective and showed better performance on growth and bulb yield of onion (17.4 ha^{-1}).

4.5.2 Quality of crops influenced by organic sources

The data on quality parameter of crops is furnished in table-9. The quality parameter such as ascorbic acid in fruit, protein content and oil content was analysed.

4.5.2.1 Ascorbic acid (mg 100 ml^{-1})

The ascorbic acid concentration of mandarin was ranged from 47.24 to 49.15 mg 100 ml^{-1}. The results revealed that, more concentration of ascorbic acid was observed in organically grown mandarin over the inorganically grown mandarin. The maximum ascorbic acid concentration was recorded at Chacher when Ghanjivamrut @ 500 kg ha^{-1} was applied. Similar findings were reported by Duarte *et al.* (2010) that, the highest concentrations of vitamin C were recorded in fruits from organic farming, but the response depended on species and cultivar. The concentration of ascorbic acid in tomato found more in organically cultivated tomato (23.37 mg 100 ml^{-1}) where Ghanjivamrut @ 500 kg ha^{-1} was applied over the inorganically grown tomato (22.81 mg 100 ml^{-1}) at Selu.

Similar findings were reported by Pal *et al.* (2015) observed that, the maximum total soluble solids, ascorbic acid, total sugars, reducing sugar, non-reducing sugar with the application of (T6) FYM 50 % +Vermicompost 50 %.

Table No. 9 Quality of crops influenced by organic sources

Mandarin				
Location	**Crops**		**Source**	**Ascorbic Acid (mg 100 ml^{-1})**
Selu	1)	Mandarin *e*	Organic	48.82
	2)	Mandarin	Fertilizer	47.36
Gangner	1)	Mandarin *e*	Organic	47.61
	2)	Mandarin	Fertilizer	46.26
Chacher	1)	Mandarin *e*	Organic	49.15
Chinchbhavan	1)	Mandarin *e*	Organic	47.24
Tomato				
Location	**Crops**		**Source**	**Ascorbic Acid (mg 100 ml^{-1})**
Selu	1)	Tomato *e*	Organic	23.37
	2)	Tomato	Fertilizer	22.81
Rice				
Location	**Crops**		**Source**	**Protein (%)**
Gangner	1)	Rice **b**	Organic	7.74
Chacher	1)	Rice **b**	Organic	7.36
	2)	Rice	Fertilizer	7.18
Soyabean				
Location	**Crops**		**Source**	**Oil (%)**
Gangner	1)	Soybean **d**	Organic	17.90
Chacher	1)	Soybean **c**	Organic	18.14
	2)	Soybean	Fertilizer	18.20

a = 10 t FYM ha^{-1}, ***b*** = 5 t FYM ha^{-1}, ***c*** = 2.5 t FYM ha^{-1},
d = Jivamrut @ 500 lit ha^{-1}, ***e*** = Ghanjivamrut @ 500 kg ha^{-1}.

4.5.2.2 Protein (%)

From the data, protein per cent of rice grain varied from 7.16 to 7.74 per cent. The highest protein percent observed in Gangner location when FYM @ 5 t ha^{-1} applied. The result showed that, the higher protein concentration was in organically grown rice. Tiwari *et al.*

(2001) observed that application of 10 tone FYM ha^{-1} produce higher protein content of rice grain.

4.5.2.3 Oil (%)

The data about oil content in soybean depicted in table 9. The oil percent in soybean ranges from 17.90 to 18.20 percent. The maximum oil percent was recorded in inorganically grown soybean but it was nearly same of organically grown soybean.

4.6 Correlation matrix between various soil properties and yield of crops.

4.6.1 Correlation matrix between various soil properties and yield of Mandarin

From the data presented in table 10, the fruit yield of Nagpur mandarin was significantly and positively correlated with available N (r =0.546*), available K (r = 532*) and $CaCO_3$ (r = 0.624) and negatively correlated with EC (r = -0.026) under different management practices. Earlier studied demonstrated the similar positive correlation of soil available N and P with fruit yield of Nagpur mandarin reported by (Srivastava and Singh, 2001).

Table No. 10 Correlation of different chemical properties of soil with yield of Nagpur mandarin

	Yield t ha^{-1}	pH	EC dSm^{-1}	O.C g kg^{-1}	CaCO3 (%)	N kg ha^{-1}	P kg ha^{-1}	K kg ha^{-1}
Yield t ha^{-1}	1							
pH	0.451	1						
EC dSm^{-1}	-0.026	-0.111	1					
O.C g kg^{-1}	0.163	-0.405	0.119	1				
CaCO3 (%)	0.624**	0.320	0.057	0.170	1			
N kg ha^{-1}	0.546*	-0.100	0.172	0.804**	0.285	1		
P kg ha^{-1}	0.273	0.144	0.012	0.090	0.208	0.293	1	
K kg ha^{-1}	0.532*	0.144	-0.116	0.361	0.509	0.536*	0.352	1

** significant at 1% level   * significant at 5% level

Organic carbon (r =0.804**) were positively and significantly correlated with available N (r=0.546*), where the N was positively correlated with K (r = 0.536*). Srivastava (2013) resulted an positively significant correlation with available N, Fe, Zn, Mn, and B with fruit yield of Nagpur mandarin.

4.6.2 Correlation of micronutrients with yield of Nagpur mandarin

From the data presented in table-11. The fruit yield of Nagpur mandarin was significantly and positively correlated with Mn (r =0.578*) and Cu (r = 0.771**). Similar findings were reported by Srivastava (2013) that, fruit yield of Nagpur mandarin positively and significantly correlated with Fe, Mn and B.

Table No. 11 Correlation of micronutrients with yield of Nagpur mandarin

	Yield t ha^{-1}	Zn (mg kg^{-1})	Fe (mg kg^{-1})	Mn (mg kg^{-1})	Cu (mg kg^{-1})
Yield t ha^{-1}	1				
Zn (mg kg^{-1})	0.120	1			
Fe (mg kg^{-1})	0.204	-0.494	1		
Mn (mg kg^{-1})	0.578*	0.450	-0.016	1	
Cu (mg kg^{-1})	0.771**	0.183	-0.060	0.435	1

** significant at 1% level * significant at 5% levels

4.6.3 Correlation matrix between various soil properties and yield of Rice

From the data of correlation, the electrical conductivity, organic carbon and available nitrogen were positively correlated with yield of rice crop (table-12). Similar observations were reported by Ahmed *et al.* (2014) that, the grain yield of rice had significant correlation with organic carbon, available N, P, and K.

Table No. 12 Correlation matrix between the properties of soils and yield of rice

	Yield t ha^{-1}	pH	EC dSm^{-1}	OC g kg^{-1}	N kg ha^{-1}	P kg ha^{-1}	K kg ha^{-1}
Yield t ha^{-1}	1						
pH	0.354	1					
EC dSm^{-1}	0.420*	0.218	1				
OC g kg^{-1}	0.602**	0.295	0.370	1			
N kg ha^{-1}	0.587**	0.254	0.399*	0.897**	1		
P kg ha^{-1}	-0.057	-0.291	-0.022	0.117	0.202	1	
K kg ha^{-1}	-0.531	-0.391	-0.341	-0.477	-0.397	-0.205	1
S Mg kg^{-1}	-0.358	0.020	-0.169	-0.109	-0.026	0.015	0.348

** Significant at 1% level * Significant at 5% level

4.6.4 Correlation matrix between various micronutrients and yield of Rice

Table No. 13 Correlation between micronutrients and yield of rice

	Yield t ha^{-1}	Zn	Fe	Mn	Cu
Yield t ha^{-1}	1				
Zn	-0.243	1			
Fe	-0.074	-0.222	1		
Mn	0.110	0.208	-0.368	1	
Cu	0.124	-0.107	0.334	-0.182	1

** Significant at 1% level * Significant at 5% level

Data showed that, Zn and Fe were negatively correlated with yield of rice crop (table -13). The Fe was negatively correlated with Mn. Correlation matrix of different variables showed that there was strong positive relationship between content of micronutrients (Zn, Mn, Cu and Fe content) each other but their relation with grain yield was fairly negatively correlated with the application of farmyard manure and nitrogen as reported by Kalfe and Sharma (2015).

Chapter V

SUMMARY AND CONCLUSION

The field investigation in relation to "EFFECT OF ORGANIC INPUTS ON SOIL PROPERTIES, YIELD AND QUALITY OF DIFFERENT CROPS UNDER CERTIFIED ORGANIC FARMS IN NAGPUR DISTRICT", was conducted during kharif-rabi season of 2017 - 2018 at the certified farmer's fields (organic field) of Nagpur district. The five locations viz., Selu, Kalmeshwar, Gangner, Saoner, Chacher and Chinchbhavan were selected for recording various observations. Soil samples were taken from 0-20 cm depth randomly selected over the field after the harvest of crop and results are summarized as below.

1. Soil pH was reduced due to the application of various organic sources under different crops. Soil pH varied from 7.69 to 8.03, 7.74 to 8.12, 7.00 to 7.85, 7.47 to 8.01, 7.01 to 7.49 and 7.29 to 7.85 at Selu, Kamaleswar, Gangner, Saoner, Chacher and Chinchbhavan, respectively when the field treated with organic sources. Application of organic materials (solid or liquid) continuously for 7 - 17 years reduced the soil pH in all locations could be ascribed to the acidifying effect of nitrogen and organic acids produced.
2. In all locations, there was no much variations in EC of soil with the application of various organic sources and chemical fertilizer alone. EC of soil was ranged between 0.215 to 0.316 dSm^{-1} with the application of organic and chemical fertilizer among the locations, which is under safe limit.
3. The soil organic varied from 4.28 to 7.81 g kg^{-1} in the field treated with various organic sources and chemical fertilizers alone and comes under the categories of medium to moderately high. The application of organic inputs from 7 to 17 years resulted an increased organic carbon content of soil by 17.06, 33.73, 46.48,

17.35, 12.75 and 30.94 per cent at Selu, Kalmeshwar, Gangner, Saoner, Chacher and Chinchbhavan, respectively over the use of inorganic fertilizer alone.

4. The soil available N content was observed between 189.00 to 349.44 kg ha^{-1} under the application of organic and inorganic inputs. These values comes under the categories of low to medium in range. The application of organic inputs from 7 to 17 years resulted in maximum available N content of soil by 2.08 to 44.18 per cent over the application of inorganic fertilizer alone. The maximum increase of available N (44.18 %) was recorded in soybean crop where Jivamrut @ 500 lit ha^{-1} was applied.

5. The available P of soil were recorded between 15.26 to 30.00 kg ha^{-1} in the present investigation. The available P was recorded less in the organic field than the fertilizer applied field up to 37.43 percent. The maximum available p was noted in Saoner village.

6. The value of available K found very high in range in the present study. The magnitude of available K ranged from 337.62 to 431.06 kg ha^{-1}. The minimum available K was observed in Chacher at soybean field under the use of FYM @ 2.5 t ha^{-1} and maximum of 431.06 kg ha^{-1} with application of inorganic fertilizer at Chinchbhavan location.

7. The available sulphur ranged from 11.03 to 14.61 mg kg^{-1} i.e low to moderately high. The higher amount of available S was recorded due to application of inorganic fertilizer than the use of organic source alone at Saoner, Kalmeshwar, Chacher, Selu and Chinchbhavan locations. It may be due to inorganic fertilizer containing sulphur.

8. The use of FYM, manurial liquid and solid organic source was found useful in maintaining the available micro-nutrient status of soil over the continuous use of inorganic fertilizer. The status of DTPA extractable micronutrients Zn, Fe, Mn and Cu (mg kg^{-1})

range from 0.48 to 0.72, 6.33 to 8.82, 4.21 to 7.83 and 2.62 to 4.51, respectively when the use of organic and inorganic sources.

9. The microbial count was influenced by application of organic inputs. The maximum microbial count was recorded in organic field over the inorganic field. The count of bacteria, fungi and actinomycetes were varied from 16.25 to 22.50 X 10^7 cfu g^{-1}, 10.75 to16.25 X 10^5 cfu g^{-1} and 7.25 to 13.5 X 10^5 cfu g^{-1} respectively.

10. The yield of Nagpur mandarin of 17.0, 16.0, and 14.5 t ha^{-1} was noted at location of Gangner, Selu and Chinchbhavann, respectively, when these farmers applied organic inputs since 7-17 years. In all the locations the yield of Nagpur Mandarin found higher as compared to national average productivity of Nagpur mandarin (10.4 t ha^{-1}). The yield of sweet orange recorded 14.0 t ha $^{-1}$ with the application of Ghanjivamrut @ 500 kg ha^{-1}. Grain yield of wheat was obtained between 1.9 kg ha^{-1} when the field applied FYM for 9 years. Maximum grain yield of pigeonpea was obtained with fertilizers alone as compared to application of organic source. The yield of vegetables was also littilbit decreased in organic field compare to the fertilizers applied field.

11. The quality of crops was improved with application of organic inputs over the fertilizers application. The higher ascorbic acid concentration (49.15 mg 100 ml^{-1}) of mandarin was recorded in chacher when ghanjivamrut @ 500 kg ha^{-1} was applied. Similarly in tomato the maximum ascorbic acid contain (23.37 mg 100 ml^{-1}) was recorded in organically produce tomato. The protein percent of rice was found maximum in organic field.

12. Correlation matrix observed that $CaCO_3$, N, K, Cu and Mn maintained positive relationship with the yield of mandarin crops. EC, OC and N were positively correlated with yield of rice crop.

Conclusions

From the study it can be concluded that, the application of organic inputs improve the chemical, biological properties and fertility status of soil.

In case of yield due to organic inputs littilbit decreased. Therefore organic and inorganic fertilizers in balanced form are efficiently sustain and enhance the fertility status of soil and maintained the yield and nutritional quality of various crops.

Chapter VI

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VITA

Name of Student : Sawant Akshay Prakash

Date of Birth : 8 April 1994

Name of the College : College of Agriculture, Nagpur

Residential Address : At : Lohare

Post : Bopardi

Tal : Wai

Dist : Satara

Pincode : 412803

Mob. No.7709039641

5. Academic qualifications :

Sr. No.	Name of Degree awarded	Year in which obtained	Division / Class	Name of awarding University	Subjects
1	B.Sc. Agri	2016	Second	Dr. M. P. K. V., Rahuri	Agriculture
2	H.S.C.	2009	First	Kolhapur Board	Phy, Che, Bio.
3	S.S.C.	2007	First	Kolhapur Board	Mar, Sans, Eng,

6. Field of interest : Teaching and Research work in Agriculture Sector.

Place: Nagpur **Signature of student**

Date: 11/06/2018

APPENDIX I

STATEMENT SHOWING THE WEEKLY METROLOGICAL DATA FOR THE YEAR 2017 – 2018 RECORDED AT COLLEGE OF AGRICULTURE NAGPUR.

Date		Met Week	Temp ^{0}c		R.H. %		Total Rainfall (mm)	No. of Rainy days	Evaporation (mm)
			Max	Min	Morn	Eve			
01 – 07	Jan 17	1	29.7	9.5	71	34	00.0	0	2.3
08 – 14		2	26.4	9.2	75	45	01.4	0	2.4
15 – 21		3	28.4	9.5	80	36	00.0	0	2.3
22 – 28		4	30.4	11.7	75	32	00.0	0	3.0
29 – 04	Feb 17	5	26.3	10.3	63	29	00.0	0	2.9
05 – 11		6	31.9	11.9	60	28	00.0	0	3.5
12 – 18		7	31.7	13.7	65	31	00.0	0	3.6
19 – 25		8	35.1	13.5	41	18	00.0	0	4.8
26 -04	Mar 17	9	35.0	13.7	32	15	00.0	0	6.0
05 – 11		10	34.3	16.5	51	26	00.2	0	5.8
12 – 18		11	33.6	13.9	30	17	00.0	0	6.2
19 -25		12	37.1	16.7	31	14	00.0	0	6.8
26 – 01	Apr 17	13	41.5	19.4	30	11	00.0	0	6.9
02 – 08		14	42.0	22.3	35	17	00.0	0	8.2
09 – 15		15	41.1	18.9	27	13	00.0	0	8.3
16 – 22		16	43.8	23.4	25	10	00.0	0	10.6
23 – 29		17	41.8	23.8	20	11	00.0	0	10.8
30 – 06	May17	18	41.8	24.7	33	17	00.0	0	8.8
07 – 13		19	41.7	24.9	35	17	00.0	0	8.9
14 – 20		20	44.2	26.9	21	14	00.0	0	11.3
21 – 27		21	44.1	28.2	26	14	00.0	0	11.0
28 – 03	Jun 17	22	41.2	24.7	49	29	13.0	2	8.5
04 – 10		23	40.6	27.7	56	35	00.2	0	7.8
11 – 17		24	38.2	24.7	69	38	33.4	3	6.5
18 – 24		25	38.3	24.9	54	37	32.4	2	8.8
25 – 01	Jul 17	26	33.0	23.7	79	63	189.2	4	7.5
02 – 08		27	32.1	23.9	75	61	24.8	2	4.3
09 – 15		28	30.6	23.2	82	68	15.4	1	3.4
16 – 22		29	30.0	23.0	85	74	171.4	3	3.1
23 – 29		30	29.6	22.5	80	69	34.6	5	2.7
30 – 05	Aug17	31	32.8	24.0	73	56	00.0	0	3.7
06 – 12		32	29.8	22.7	85	71	78.0	4	3.0
13 – 19		33	32.2	23.6	78	57	163.8	3	3.1
20 – 26		34	30.5	22.5	86	69	25.4	3	2.4
27 – 02	Sep17	35	31.4	22.7	81	65	77.8	3	3.7
03 – 09		36	31.2	23.2	80	68	14.6	2	3.1
10 – 16		37	31.7	22.7	89	69	60.2	4	2.6
17 – 23		38	31.2	21.7	84	63	61.4	3	3.5
24 – 30		39	33.9	22.3	74	53	00.0	0	3.1
01 – 07	Oct 17	40	34.1	21.3	74	55	00.0	0	3.1
08 – 14		41	31.2	22.2	84	63	19.2	2	2.3
15 – 21		42	34.3	20.0	68	41	00.0	0	2.5
22 – 28		43	33.2	16.7	69	35	15.6	1	2.9
29 – 04	Nov 17	44	31.8	18.4	67	36	00.0	0	2.1
05 – 11		45	30.3	18.0	65	35	00.0	0	2.8
12 – 18		46	30.3	15.8	69	41	00.0	0	2.3
19 – 25		47	30.9	16.0	63	37	00.0	0	2.6
26 – 02	Dec 17	48	29.9	12.4	64	27	00.0	0	2.3
03 -09		49	28.8	11.5	64	32	00.0	0	2.2
10 -16		50	29.8	13.0	67	31	00.0	0	2.3
17 -23		51	28.6	10.8	67	29	00.0	0	2.4
24 -31		52	28.7	11.0	60	21	00.0	0	2.4
10 – 07	Jan 18	01	27.9	9.6	67	29	00.0	0	2.4
08 -14		02	28.3	9.9	60	26	00.0	0	2.5
15 – 21		03	29.4	11.2	57	22	00.0	0	2.9
22 – 28		04	28.6	11.0	47	23	00.0	0	3.0
29 – 04	Feb 18	05	31.6	10.3	50	16	00.0	0	3.3