EFFECT OF DIFFERENT SOURCES OF ORGANIC MANURES AND THEIR COMBINATION ON YIELD AND NUTRIENT UPTAKE BY CHILLI (*Capsicum annum* L.) IN LATERITIC SOIL OF KONKAN

A thesis submitted to the

DR. BALASAHEB SAWANT KONKAN KRISHI VIDYAPEETH, DAPOLI
(Agricultural University)
Dist. - Ratnagiri (Maharashtra State), India

In partial fulfilment of the requirements for the degree of

Master of Science (Agriculture)

in

SOIL SCIENCE AND AGRICULTURAL CHEMISTRY

by

Mr. VIKRAM DADASAHEB KAPSE

B.Sc. (Ag.)

DEPARTMENT OF SOIL SCIENCE AND AGRICULTURAL CHEMISTRY,

FACULTY OF AGRICULTURE,

DR. BALASAHEB SAWANT KONKAN KRISHI VIDYAPEETH,

DAPOLI - 415 712, DIST. RATNAGIRI (M.S.)

May, 2016

EFFECT OF DIFFERENT SOURCES OF ORGANIC MANURES AND THEIR COMBINATION ON YIELD AND NUTRIENT UPTAKE BY CHILLI (*Capsicum annum* L.) IN LATERITIC SOIL OF KONKAN

A thesis submitted to the

DR. BALASAHEB SAWANT KONKAN KRISHI VIDYAPEETH, DAPOLI

(Agricultural University)

District - Ratnagiri (Maharashtra State), India

In partial fulfilment of the requirements for the degree of

Master of Science (Agriculture)

in

SOIL SCIENCE AND AGRICULTURAL CHEMISTRY

by

Mr. VIKRAM DADASAHEB KAPSE

B.Sc. (Ag.)

Approved by the Advisory Committee

Chairman and Research Guide

(N.B. Gokhale)
Incharge,
Plant Biotechnology Centre,
Dr. B.S.K.K.V., Dapoli.

Members:

(M.C. Kasture)
Assistant Professor
Dept. of Soil Science and Agril. Chemistry,
College of Agriculture, Dapoli.

(P.B. Sanap)
Vegetable Specialist,
Vegetable Improvement Scheme,
Central Experiment Station,
Wakawali.

(M.M. Kulkarni)
Assistant Professor
Department of Horticulture,
College of Agriculture, Dapoli.

Dr. N.B. Gokhale
M.Sc (Ag.) Ph.D.
Incharge,
Plant Biotechnology Centre,
Dr. B.S.K.K.V., Dapoli.

CERTIFICATE

This is to certify that, the thesis entitled **"EFFECT OF DIFFERENT SOURCES OF ORGANIC MANURES AND THEIR COMBINATION ON YIELD AND NUTRIENT UPTAKE BY CHILLI (*Capsicum annum* L.) IN LATERITIC SOIL OF KONKAN"** submitted to the Faculty of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri (Maharashtra State), in the partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **SOIL SCIENCE AND AGRICULTURAL CHEMISTRY,** embodies the results of a piece of *bona-fide* research carried out by **Mr. VIKRAM DADASAHEB KAPSE (Regd. No. 2369)** under my guidance and supervision and that no part of this thesis has been submitted for any other degree or diploma or published in other form. All the assistance and help received during this course of investigation and the sources of literature has been duly acknowledged by him.

Place: Dapoli
Date: / / 2016

(N.B. Gokhale)
Chairman,
Advisory Committee and
Research Guide

EFFECT OF DIFFERENT SOURCES OF ORGANIC MANURES AND THEIR COMBINATION ON YIELD AND NUTRIENT UPTAKE BY CHILLI (*Capsicum annum* L.) IN LATERITIC SOIL OF KONKAN

By

Mr. VIKRAM DADASAHEB KAPSE

B.Sc. (Ag.)

DEPARTMENT OF SOIL SCIENCE AND AGRICULTURAL CHEMISTRY,
FACULTY OF AGRICULTURE,

DR. BALASAHEB SAWANT KONKAN KRISHI VIDYAPEETH,
DAPOLI - 415 712, DIST. RATNAGIRI (M.S.)

MAY, 2016

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATE

ACKNOWLEDGMENT

It gives me great pleasure in writing this acknowledgement, as a token of gratitude to all the people who have always been supportive and helpful throughout the course of these studies. I bow my head before the God almighty for the blessings showered on me, which alone helped me to complete this project.

First and foremost I express my heartfelt gratitude towards my research guide and Chairman of my advisory committee Dr. N. B. Gokhale, In-charge, Plant Biotechnology Centre, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Sir has unquestioned mastery on the subject, profound interest in the research, inspiring guidance, constructive criticism, ever witting help, kind and soft touch of love forever for giving me the opportunity for selecting the present research problem and providing all the possible help throughout the study period. I am indebted to him for his guidance, constant encouragement, faith and confidence in me, for lending me a 'free hand' to work and providing everything necessary during the course of work ..Thank You Sir!

I cannot refrain to accord my deep sense of gratitude towards the Member of my Advisory Committee ***Dr. M.C. Kasture****, Assistant Professor, Department of Soil Science and Agricultural Chemistry, College of Agriculture, Dapoli,* ***Dr. P. B. Sanap,*** *Vegetable Specialist, Vegetable improvement Scheme, Wakawli and* ***Prof. M. M. Kulkarni****, Assistant Professor, Department of Horticulture, for their inspiration, kind and helpful suggestion, valuable advice during the course of study.*

I am extremely grateful to visionary to ***Dr. Tapas Bhattacharyya,*** *Vice Chancellor, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, for his keen interest, devotion and constant efforts to do the best for the University. His positive attitude and motivational abilities, ever-dynamic personality, energetic nature and strive for excellence will always remain a source of inspiration for me. I also place on record my cordial thanks to,* ***Dr. R.G.Burte,*** *Dean and Director of Instruction, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, and* ***Dr. S. A. Chavan,*** *Associate Dean, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, for providing permission and all the necessary facilities in time, throughout the period of my post-graduation studies.*

*I gratefully acknowledge the co-operation and help extended by **Dr. S.S. Prabhudesai,** Head, Department of Soil Science and Agril. Chemistry, **Dr. K.D. Patil,** Khar Land Research Scientist, **Dr. S.B. Dodake,** Deputy Director of Research, Dr.B.S.K.K.V., Dapoli, **Dr. V.G. Salvi,** and **Dr. K.P.***

***Vaidya,** Associate professors, Department of Soil Science and Agril. Chemistry, College of Agriculture, Dapoli, for their constant encouragement, moral support and inspiration.*

*Words fail me to express my appreciation to **Dr. M.C. Kasture** Assistant Professor and **Dr. Pooja S. Sawant,** Assistant Professor and P.G. Academic In-Charge, for their support. They were always beside me during the happy and hard moments. I acknowledge**, Prof. R. V. Dhopavkar, Prof. N. H. Khobragade,** for their help and good wishes.*

*I would like to pen out names of **Dr. S. S. More**, Assistant Professor, Department of Soil Science & Agricultural Chemistry and **Shri Sundar Chavan,** Agril. Assistant, Department of Soil Science & Agricultural Chemistry here in golden words, who worked in the same way and helped in the preparation of this manuscript, will be a treasure to me forever.*

*I acknowledge my sincere thanks to **Dr. N.A. Meshram**, Scientist S-I, AICRP on Agroforestry, Tetawali, CES, Wakawali and **Shri.A. A. Dademal,** Ph. D. (Scolar) for their constant encouragement, moral support and kind co-operation.*

*I am very much thankful to **Dosani Sir, Smt.Bhosale Madam, Mahadik Kaka, Munna Bhai, Ramesh Kaka, Prakash Dada, Amol dada, Satish dada, Nikita Didi** and **Abhijit** for their timely help and co-operation.*

*I would like to sincerely thank **Shri. Pawar Sir,** Agril. Assistant, and **all labours,** Vegetable improvement Scheme, Pngari Block, CES, Wakawali. Who helped me and provide necessary facilities during my research work.*

No research is possible without the Library, the center of learning resources. I take this time to express my gratitude to all the library staff and education staff for their services.

This project could not accomplished without the support of my M.Sc. batch mates** Ajinkya, Rahul, Santosh, Mohan, Darshana **and** Harshala **who helped me lot in all respect and love offered to me throughout degree course. **My special thanks to** Bhosale and Gavade families **for their love and cooperation.**

Though thanks are considered a taboo in friendship I cannot stop myself from placing cordial thanks to my Best senior friend** Unmesh Puranik **for being a part of not only the good

moments but also the odd ones. I want to express appreciation to *Rajkumar Bankar* ***and*** *Subodh Pawar* ***for contributing to this work by giving practical advice and sharing ideas.***

My special thanks to my senior friends *Vijaykumar Palsande, Vibhavati Borkar, Nandini Joshi, Amol Shinde, Sunanda Gavit, Ashwini Patil, Sushil Zodge, Prakash Tapkir, Tanaji Sadgir, Manoj Deo, Jayasri Kadu and Mayuri Bavdhankar.* ***I also thank my caring and lovable junior friends*** *Sagar, Nayan, Snehal, Deepali, Manisha, Pranali, Aparna* ***and*** *Ananta* ***for their kind co-operation.***

My sincere thanks to my M.Sc. colleagues *Vishal, Vikram, Nikhil, Krushna, Balwant, Amit, Rama, Sagar, Vijay B., Vijay S., Amrut, Saurabh, Ajinkya, Rahul, Umesh, Dutta, Bharat, Bharatesh, Suraj[3], Rohan, Sachin, Mayur, Parmeshwar, Ashu, Vaibhav, Ashish, Suyog, Nishikant, Rahul Bhilare, Manisha, Sneha, Sonali, Rasika, Bhakti, Yogita, Neha, Ashwini, Jagruti, and Yogini.* ***Also my sincere thanks to*** **Ph.D** ***Seniors*** Prashant Hegde, Santosh Raut, Gaurao Kurhade, Anirudha Khaire, Ganesh Bahure, Pravin Raut, Sachin Mule, Dnyandeo Khedkar, Ganesh Shendge and Miss Poonam Naik **for their love, friendship, cooperation and help during the *M.Sc.* programme.**

I express my heartfelt gratitude towards my beloved father ***Mr. Dadasaheb Kapse*** *and beloved mother* ***Mrs. Sangita Kapse****, for their bondless love, constant encouragement, support and blessings made by them to shape my career. I also extend my heartfelt gratitude to my brother* ***Akshay*** *who has been an unending source of inspiration and affection for me. I also wish to convey my thanks to all my cousins and relatives, who always supported me with their love and inspiration.*

I owe a lot to my parents, who encouraged and helped me at every stage of my personal and academic life, and longed to see this achievement come true. I would like to pay high regards to my Late grandfather ***Shri. Dattatray Changdev Kapse****, Grandmother* ***Smt. Yashodabai Dattatray Kapse, Uncle Shri. Kalyan D. Kapse, Aunt Mrs. Meena K Kapse*** *and cusions* ***Nikhil, Abhijeet, Akash,*** *and* ***Pruthviraj.***

I consider myself fortunate to have the joyful company of my dearest friends, ***Nana, Ram, Rahul, Amar Sumit, Mahesh, Sagar[2], Anna, Kaka, Sharad[2]*** *etc. who stood with me through my thick and thin, always tried to turn my tear into smile, and above all being my friends.*

Last but not least, it is difficult to express my gratitude towards my family and relatives. The thesis would have remained an unfulfilled dream without their unquestioning love, moral *support and fine blessings. THANKS FOR EVERYTHING…I am nothing without you…you are all simply wonderful….!*

Your prayer for me was what sustained me thus far. I would also like to thank all of my friends who supported me in writing, and incented me to strive towards my goal.

Once again, I would like to acknowledge all those who I might have left on unknowingly. I carry this thesis with my head held high.

Any omission in this brief acknowledgement does not mean lack of gratitude.

Place: Dapoli

Date: . . 2016 (Vikram Dadasahe Kapse)

DEPARTMENT OF SOIL SCIENCE AND AGRICULTURAL CHEMISTRY,
COLLEGE OF AGRICULTURE, DAPOLI
DR. B. S. KONKAN KRISHI VIDYAPEETH, DAPOLI, DIST. RATNAGIRI (M.S.)

Name of the student	:	Mr. Vikram Dadasaheb Kapse
Registration No.	:	2369
Name and designation of Research Guide	:	Dr. N. B. Gokhale Incharge, Plant Biotechnology Centre, Dr. B.S.K.K.V., Dapoli.
Title of Thesis	:	**"Effect of different sources of organic manure and their combination on yield and nutrient uptake by chilli (*Capsicum annum* L.) in lateritic soil of Konkan"**

===

ABSTRACT

The present investigation entitled "Effect of different sources of organic manure and their combination on yield and nutrient uptake by chilli (*Capsicum annum* L.) in lateritic soil of Konkan" was conducted at Vegetable Improvement Scheme, Pangari Block, Wakawali during *Rabi season* 2014-2015. The field experiment was laid out in Randomized Block Design comprising of thirteen treatments replicated thrice. Treatments comprised of T_1 [25% N through FYM + 75% N through Urea], T_2 [50% N through FYM + 50% N through Urea], T_3 [75% N through FYM + 25% N through Urea], T_4 [25% N through Vermicompost + 75% N Urea], T_5 [50% N through Vermicompost + 50% N through Urea], T_6 [75% N through Vermicompost + 25% N through Urea], T_7 [25% through N Poultry manure + 75% N through Urea], T_8 [50% through N Poultry manure + 50% N through Urea], T_9 [75% N through Poultry manure + 75% N through Urea], T_{10} [25% N through Groundnut cake + 75% N through Urea], T_{11} [50% N through Groundnut cake + 50% N through Urea], T_{12} [75% N through Groundnut cake + 25% N through Urea] and T_{13} [Absolute control].

The initial experimental soil was sandy clay loam in texture, slightly acidic in reaction and low in electrical conductivity. The soil was to be found very high in organic carbon and was low in available N and P_2O_5. The soil was

high in available K_2O. DTPA extractable micronutrients (Fe, Mn, Zn and Cu) were found to be 28.86, 114.0, 0.372 and 2.752 (mg kg^{-1}), respectively.

It was observed that the substitution of N through poultry manure to the extent of 50 per cent (and remaining 50 per cent through urea) was observed to be the best treatment amongst different combinations of organic manures with urea. It produced highest yield (Green, dry matter of green chilli pod and stover) of chilli and weight of fruit per plant while application of 75 per cent N through Poultry manure and 25 per cent N through urea recorded highest plant height at different stages (i.e. 30, 60 DAT and at harvest).

The quality parameter as indicated by ascorbic acid and capsaicin content, the NPK uptake by green pod and stover was also recorded maximum in combined application of organic and inorganic fertilizers. It was also observed that the residual available nutrients in soil also significantly influenced due to integrated nutrient management.

It could be concluded from the above investigation that the different combination of poultry manure with urea (50 per cent through poultry manure and 50 per cent N through urea, 75% N through poultry manure and 25% N through urea) was found to be the best treatments in increasing yield (stover and pod) of chilli Var. Konkan Kirti as well as improving the soil properties in lateritic soils of Konkan.

CHAPTER I
INTRODUCTION

Chilli (*Capsicum annum* L.) is one of the most important commercial crops of India which belongs to family Solanaceae. It is also called as hot pepper, red pepper, cayenne pepper, capsicum, etc. Most of the cultivated varieties in India belong to the species *Capsicum annum*. It is grown almost throughout the country. India is the largest producer of chillies in the world and earns valuable foreign exchange for the country (Venkateshalu, 2009).

Chillies are excellent source of vitamin A, C and E with minerals like molybdenum, magnesium, potassium and copper. It is an essential ingredient of Indian curry, which is characterized by tempting colour and exciting pungency. It is predominantly popular for its green pungent fruits, which is used for culinary purpose. It is used in salads, chutney, sauces, pickles and it is a main ingredient of Indian diet in every home. The nutritive value of chilli is important for human diet. Chilli contains an alkaloid, 'capsaicin' which is a substituted benzyl amine derivative. Capsaicin is of great medical value and it has been reviewed to evaluate its effect in treatment of painful conditions such as: rheumatic diseases, cluster headache, painful diabetic neuropathy, post herpetic neuralgia, etc. (Tsuchiya, 2001).

In India, area under chilli is about 774.87 thousand hectare and production 1492.14 thousand MT with productivity of 1.9 thousand MT per hectare (Anonymous, 2015).The crop is very important for agricultural economy and is used in processing industries. India is the largest producer, consumer and exporter of chilli, which contributes to 25% of total world's production. In India the most important chilli growing states are Karnataka, Tamil Nadu, Odisha, Maharashtra, Rajasthan and West Bengal. Andhra Pradesh is the largest producer of chilli in India, contributes about 30 per cent to the total area under chilli, followed by Karnataka (20 %), Maharashtra (15%), Odisha (9%), Tamil Nadu (8%) and other states contributing 18% to the total area under chilli (Kumar, 2013).

Adequate and balanced fertilizer management in association with manures is very much essential to exploit the full yield potential of Chilli. After the green revolution, increase in production was achieved at the cost of soil health. It has been proved that indiscriminate use of inorganic fertilizers results in decrease in soil fertility and increase in soil acidity with depletion of organic humus content in addition to poor crop quality. Use of organic manures to meet the nutrient requirements of crop would be an inevitable practice in the years to come for sustainable agriculture since organic manures not only improve the physical, chemical and biological properties of soil (Heitkamp *et al.*, 2011) but also improves the moisture holding capacity of soil, thus resulting in enhanced crop productivity alongwith better quality of crop produce (Premsekhar and Rajashree, 2009). Hence fertilizers, manures and other amendments either alone or in combinations could be used to enhance nutrient supplying capacity of the soil (Dutta and Sangtam, 2014). The yield of chilli depends on adequate supply of the essential nutrients (Alabi, 2006). According to Stroehlein and Oebker (1979) N application to chilli peppers showed a significant increase in plant growth characteristics, colour and nutrient content of leaves and yield.

The chemical fertilizers like N, P and K have played significant role in increasing the yield and quality in plants during early seventies. But in recent years the usage of chemical fertilizers indiscriminately in an unbalanced manner has been shown to result in several problems like loss of fertility, soil health and multiple nutrient deficiencies and loss of microbial activities etc, which ultimately results in reduced crop productivity and quality.

With the increase in population and demand our compulsion is not only to stabilize agricultural production but also to increase it further in sustainable manner. Excessive use over years of agro-chemicals like pesticides and fertilizers has affected the soil health and lead to declining of crop yields and quality of products. Whereas, the excessive use of inorganic source of nutrients for its cultivation creates health hazards, a natural balance needs to be maintained at all costs for existence of life and property.

The soils of Konkan region are acidic, well drained, highly percolated having low CEC which causes the unfavourable condition to crop growth and productivity. The soil erosion is also the major problem in this region due to high rainfall and causes the high losses of nutrient from the soil. That's why soils of this region being poor in native fertility and nutrient retention capacity. These soil also have very high nitrogen losses by leaching and volatilization. So there is need to maintain the soil fertility and productivity. The importance of organic matter in improving the soil fertility is well recognised. In development of fertile soil, organic substances play a direct role as these are the sources of plant nutrients which are liberated in available form during mineralization process. Organic matter like farm yard manure, vermicompost, poultry manure and crop residues are considered as a store house of various nutrients which are essential for the plant growth. During the decomposition of organic matter there is gradual release of plant nutrient with subsequent mineralization to carbon, nitrogen, phosphorus, and other elements. Use of organic manures alone cannot fulfil the crop nutrients requirement. Mixture of organic manures and inorganic fertilizers gave better results than organic manure alone (Chinnaswami, 1967). There is a proper ratio between the organic and chemical sources and it should be worked out to derive the best combination of the inputs for attaining quantity and quality in chilli. The integrated supply and use of plant nutrients from chemical fertilizers and organic manures has shown to produce higher crop yields than when they are applied alone (Chinnaswami, 1967).

Keeping these things under consideration use of organics and their combination in chilli cultivation as target dose of application and to study its effect on growth, yield and biochemical parameters of chilli was undertaken.

Inclusion of organic manures with inorganic sources of nutrient is essential. It is found that integrated nutrient management with FYM, vermicompost, poultry manures and oil cakes showed a significant positive response on chillies (Pariari and Khan, 2013). Particularly chilli needs heavy manuring for better plant growth and high yield. Use of judicious combinations of organic and inorganic fertilizer sources is essential not only to maintain the soil health but also sustain the productivity (Malewar *et al.*, 1998). Hence, in light of the available information, the present investigation entitled “Effect of different sources of organic manures and their combination on yield and nutrient uptake by chilli (*Capsicum annum* L.) in lateritic soil of Konkan” was undertaken with following objectives:-

1. To study the effect of organic and inorganic sources of fertilizer in different combination on soil properties.
2. To study the effect of organic and inorganic sources of fertilizer in different combination on growth and yield of Chilli.
3. To study the effect of organic and inorganic sources of fertilizer in different combination on nutrient uptake by Chilli.

CHAPTER II

REVIEW OF LITERATURE

The present investigation was conducted on lateritic soils of Konkan region to study the effect of different sources of organic manures and their combination on yield and nutrient uptake by chilli (*Capsicum annum L.)* Cv. Konkan Kirti in lateritic soil of Konkan. The available literature on these aspects have been reviewed and presented under the following heads:

2.1 Effect of different sources of organic manures and their combination on growth and yield contributing characters.

2.2 Effect of different sources of organic manures and their combination on green chilli pod and Stover yield.

2.3 Effect of different sources of organic manures and their combination on nutrient content in plant and green chilli pod.

2.4 Effect of different sources of organic manures and their combination on uptake of nutrient by chilli plant.

2.5 Effect of different sources of organic manures and their combination on quality of chilli.

2.6 Effect of different sources of organic manures and their combination on chemical properties of soil.

2.1 Effect of different sources of organic manures and their combination on growth and yield contributing characters.

Nair and Peter (1990) recorded the highest fruit number, fruit weight per plant and yield of chilli ha^{-1} with combined application of organic and inorganic fertilizers and concluded that only either organic or inorganic fertilizer sources will not increase yield of chilli.

Natarajan (1990) noticed higher plant height and number of branches per plant in chilli when FYM was applied @ 25 t ha^{-1} as a basal dose along with 75:33:35 kg NPK ha^{-1}.

In an experiment conducted at Agriculture Improvement Station, Taiwan on chilli it is reported that plant height significantly increased with organic manures than the chemical fertilizers (Ching Fung Hsieh and Kvonon, H.1994).

Mallangouda *et al.* (1995) reported that application of the recommended dose of NPK + FYM improved the yield and yield components of capsicum. The highest fruit yield (2099.8 kg ha^{-1} FW and 577.8 kg ha^{-1} DW) was recorded with the same combination.

Subba Rao *et al.* (1998) conducted a field experiment on effect of organic manures on growth and yield of brinjal at Agriculture Research Station, Maruteru, West Godavari District during *kharif* 1997-1998 with five kinds of organic manures in different combination viz., FYM, neem leaf, vermicompost, neem cake including bio fertilizers such as Phosphobacteria and Azosprillum and compared with recommended inorganic fertilizer application (100:60:60 kg ha^{-1} of N, P_2O_5 and K_2O respectively). The study revealed that plant height as influenced by organic manures were on par with the inorganic fertilizers, maximum height was recorded in application of FYM (127.5 cm).

In a long term trial (5 years) conducted by Shashidhara (2000), the plant height, number of branches, leaf area, leaf area index, yield and yield parameters increased significantly at all growth stages due to combined application of organics (FYM/Biogas Spent Slurry/red gram stalk), inorganics (100% RDF > 50% RDF). The growth, yield parameters and yield with organics ware comparable to that of inorganics from 4th year onwards in a long term trial.

Similar, Malawadi (2003) observed that the plant height, number of branches, leaf area, Leaf Area Index, total dry matter production in various plant parts and yield of chilli recorded significantly higher values with combined application of NPK + FYM as compared to NPK alone.

The application of organics viz., FYM, chilli stalks and FYM + chilli stalks with inorganic fertilizers (RDF) significantly influenced growth, yield, nutrient uptake and quality of chilli and the magnitude of combined effect of organic and inorganics was higher than inorganics alone (Kattimani, 2004).

Kanan *et al.* (2006) conducted field experiment during December-May (2003-2004) with tomato as test crop in Agriculture College and Research Institute, Madurai to study the influence of different organic manures for N sources. They revealed that the application of 75% N through vermicompost with Azosprillum was found to be superior in plant height (76.4 cm) and dry matter production (1735 kg ha^{-1}) followed by 75% coir pit with Azosprillum which recorded increase in height (71.4 cm) and dry matter production (1632 kg ha^{-1}).

Dileep S. N. and S. Sasikala (2015) Conducted field experiments to find out the effect of different sources of organic manures along with various levels of inorganic fertilizers on growth, fruit traits, yield and quality improvement of chilli cv.K1 at the College orchard, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. From the study, it was found that the application of 75% RDF along with humic acid @ 30 kg ha^{-1} was recorded highest plant height (79.30 cm).

Talpade *et al.* (2011) conducted a field experiment on Pusa Jwala chilli to study the response to fertigation and poultry manure levels grown under black polythene mulch at College of Agriculture, Dapoli during *Kharif* season and revealed that application of 12.5 t ha^{-1} poultry manure recorded significantly superior plant height (62.73 cm) and number of pods $hill^{-1}$ (39.01) over the 5, 7.5 and 10 t ha^{-1} and statistically superior mean dry matter (112.82 $hill^{-1}$) at 90 DAT was recorded by the application of 7.5 t ha^{-1} poultry manure over 5, 10 and 12.5 t ha^{-1} poultry manure.

Rani *et al.* (2012) conducted a field experiment on evaluation of integrated nutrient management practices on growth, yield and economics of green chilli cv Pusa Jwala (*Capsicum annuum* L.) during 2007 and 2008 *rabi* season at Agricultural Research Institute, Rajendranagar, Hyderabad, Telangana state, India. Results revealed that, combined application of 150 kg N ha^{-1} along with 10 t FYM and 0.5 t neem cake ha^{-1} showed significant increase in plant height (59, 58 cm)

Pariari and Khan (2013) conducted a field experiment on integrated nutrient management of chilli (*Capsicum annuum* L.) in Gangetic alluvial plains, Department of Spices and Plantation crop, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal. Total six organic manures namely cow dung manures, vermicompost, neem cake, poultry manures, phosphocompost and mustard cake were applied in different combination with inorganic nitrogenous fertilizers (urea) at three levels (25%, 50% & 75%). They found that the growth parameter like plant height (69.56 cm) and number of branches per plant was maximum under the treatment with 50% N from vermicompost & 50%N from urea over all the other treatments.

Samsangheile and Kanaujia (2014) conducted Experiment during *rabi* seasons 2010-2011 Medziphema Nagaland to find out the effect of integrated nutrient management on growth, yield and quality of chilli (*Capsicum annum* L.) and fertility status of soil under foothill condition of Nagaland. Results revealed that the application of different levels of fertilizers, organic manures and biofertilizers either alone or in combination significantly influenced the growth of chilli as compared to control. The maximum plant height (105.58 cm) were recorded with the conjoint application of 50% NPK + 50% FYM + biofertilizers.

Singh *et al.* (2014) was conducted a field experiment to study the "Effect of organics on growth yield and biochemical parameters in chilli (*Capsicum annum* L.) cv: Suryamukhi at Sam Higginbottom Institute of Agriculture Technology and Sciences during *rabi*, 2012-13. Results revealed that, maximum plant height at 30 DAT (20.22cm), 60 DAT (40.20 cm) and 90 DAT (46.28cm) was found in plot with application of FYM (12.5 t ha^{-1}) + Vermicompost (2.5 t ha^{-1}) + Bio fertilizer (@ 2.5kg ha^{-1} Azospirillum + PSB).

Kumar *et al.* (2016) was conducted A field experiment on "Effect of INM practices on plant growth, fruit yield and yield attributes in chilli" during *Kharif* 2010-12 season at student farm of Department of Vegetable Science of College of Agriculture (CSAUA and T Kanpur). Results revealed that the application of organic matter @ 25t FYM ha^{-1} along with RDF (100:50:50kg NPK ha^{-1}) recorded higher plant height (70.6, 86.6, 99.0, 99.7cm. in Azad mirch-1 and 66.8, 72.8, 85.0, 85.9 cm in Chanchal variety) at 60, 90, 120 Days and at harvesting.

2.2 Effect of different sources of organic manures and their combination on green chilli pod and Stover yield.

Subbaiah *et al.* (1982) reported that combined application of 25 t FYM ha^{-1} and inorganic fertilizer (80:35:35 kg NPK ha^{-1}) was found to be beneficial in increasing the yield of chilli as compared to application of inorganic fertilizer alone.

Application of varying levels of N with and without FYM was studied at Agricultural College, Tirupathi by Narasappa *et al.* (1985). According to them, the yield of green chilli was maximum at 150 kg N + 10 t of FYM ha^{-1}, with an increase of 60.42 per cent increase yield over the control.

Nair and Peter (1990) recorded the highest fruit number, fruit weight $plant^{-1}$ and yield of chilli ha^{-1} with combined application of organics and inorganics and concluded that only organic or inorganic fertilizer sources will not increase yield of chilli. Among the various organic manures, the compost produced by earthworms (vermicompost), is a rich source of macro and micronutrients proved to be the best.

Effect of various nitrogen levels through FYM and urea on yield of chilli was studied by Chavan *et al.* (1997) and revealed that the application of 150 kg N ha^{-1} through combination of FYM & urea i.e 75 kg N ha^{-1} through FYM+75 kg N ha^{-1} through urea recorded maximum yield of green chilli (6802.60 kg ha^{-1}) and total dry matter production of plant (854.57 kg ha^{-1}) over the application of 150 kg N ha^{-1} through FYM & urea alone. Jasvir Singh *et al.* (1997) registered higher fruit yield per plant in chilli with the application of vermicompost @ 10 t ha^{-1} and observed that inclusion of vermicompost along with 100 per cent RDF + FYM resulted in additional dry chilli yield of 1.68q ha^{-1}.

According to Malawadi (2003), the yield of chilli recorded significantly higher values with combined application of NPK + FYM as compared to NPK alone.

Response of Chilli to poultry manure levels was studied by Talpade *et al.* (2011) during the month of December 2004 to April 2005 at College of Agriculture, Dapoli. With F_1 as fertilizer application as per RDF and F_2, F_3, and F_4 were the fertigation treatment with 75, 100 and 125 per cent of RDF (150: 50: 50 kg N, P_2O_5, K_2O kg ha^{-1}) respectively and sub plot treatments of levels of poultry manure M_1,

M_2, M_3 and M_4 with a dose of 5, 7.5, 10.0 and 12.5 t ha^{-1}, respectively. They revealed that the green chilli yield attributes viz., number of fruit $hill^{-1}$, statistically superior values by treatment F_4 and M_4 over rest of the fertigation and manure levels. The statistically superior values of weight of fruits $hill^{-1}$ was recorded significantly superior weight of fruits $hill^{-1}$ over rest of the poultry manure levels.

Hiraguli and Allolli (2012) conducted a field experiment was conducted on black soil at Regional Agricultural Research Station, Raichur during Rabi 2003, to study the response of chilli (cv. Byadagi Kaddi) to combined application of organic, inorganic and biofertilizers. Results revealed that, chilli nourished with FYM @ 25 t ha^{-1} + 100 per cent RDF, gave significantly higher yield (7.42 q ha^{-1}.) followed by chilli which was supplemented with FYM @ 75 t ha^{-1} + Azospirillum+ Phosphate solubilizing bacteria (PSB) +25 per cent RDF (6.25 q ha^{-1}).

Rani *et al.* (2012) conducted a field experiment on evaluation of integrated nutrient management practices on growth, yield and economics of green chilli cv Pusa Jwala (*Capsicum annuum* L.) during 2007 and 2008 *rabi* season at Agricultural Research Institute, Rajendranagar, Hyderabad, Telangana state, India. Results revealed that, combined application of 150 kg N ha^{-1} along with 10 t FYM and 0.5 t neem cake ha^{-1} showed significant increase in yield $plant^{-1}$ (410, 315 g) and total green chilli yield of 13306 and 10550 kg ha^{-1} respectively.

Pariari and Khan (2013) conducted a field experiment on integrated nutrient management of chilli (*Capsicum annuum* L.*)* in Gangetic alluvial plains of West Bengal. they applied six organic manures namely cow dung manures, vermicompost, neem cake, poultry manures, phosphocompost and mustard cake in different combination with inorganic nitrogenous fertilizers (urea) at three levels (25%, 50% & 75%). They revealed that application of 50% N from vermicompost & 50% N from urea recorded highest yield of individual plant (136.37 fruit) over all the other treatments.

Jayanthi *et al.* (2014) conducted a field experiments during 2012 – 2013 on clay loam soil at Vallampadugai, Chidambaram, Cuddalore District, Tamil Nadu, India, to evaluate the efficacy of vermifertilizer (VF) on the soil quality characteristics, and on the yield and quality characteristics of chilli (*Capsicum annuum* L.*)* in comparison to inorganic fertilizers (NPK). Vermifertilizer (5 t ha^{-1}) and vermifertilizer supplemented with recommended dose of chemical fertilizer (RDCF) (120:60:30 kg ha^{-1}) (w/w) had significantly ($P<0.05$) increased the yield of chilli fruit (both fresh and dry fruit weight).

Samsangheile and Kanaujia (2014) conducted Experiment during *rabi* seasons 2010-2011 at Nagaland to find out the effect of integrated nutrient management on growth, yield and quality of chilli (*Capsicum annum* L.) and fertility status of soil under foothill condition of Nagaland. Results revealed that the application of different levels of fertilizers, organic manures and biofertilizers either alone or in combination significantly influenced the yield of chilli as compared to control. The maximum green fruit yield (19.47 t ha^{-1}) were recorded with the conjoint application of 50% NPK + 50% FYM + biofertilizers.

Dileep S. N. and S. Sasikala (2015) Conducted field experiments to find out the effect of different sources of organic manures along with various levels of inorganic fertilizers on growth, fruit traits, yield and quality improvement of chilli cv.K1 at the College orchard, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. From the study, it was found that the application of 75% RDF along with humic acid @ 30 kg ha^{-1} was recorded highest yield per plant (347.14 and 90.49 g), per plot (7.71 and 2.01 kg) and per ha. (12.86 and 3.35 t) of fresh and dry fruits, respectively.

Tambe *et al.* (2015) conducted a field experiment on effect of integrated nutrient management on yield, quality improvement and nutrient uptake of chilli at experimental farm at Department of Soil

Science and Agricultural Chemistry, V. N. M. K. Vidyapeeth, Parbhani during *kharif* season using chilli crop with variety Pusa Jwala. Results revealed that, the application of 50 per cent RDF + 2.5 t ha^{-1} vermicompost + 2 sprays of Vermiwash was recorded significantly highest total chilli yield (86.85 q ha^{-1}).

Kumar *et al.* (2016) was conducted A field experiment on "Effect of INM practices on plant growth, fruit yield and yield attributes in chilli" during *Kharif* 2010-12 season at student farm of Department of Vegetable Science of College of Agriculture (CSAUA and T Kanpur). Results revealed that the application of organic matter @ 25t FYM ha^{-1} along with RDF (100:50:50 kg NPK ha^{-1}) recorded higher fruit yield (201.99 and 145.32 g plant^{-1}) in Azad mirch-1 and Chanchal chilli.

2.3 Effect of different sources of organic manures and their combination on nutrient content in plant and green chilli pod.

Dademal and Dongale (2004) conducted an experiment to know the effect of application of organic manures and fertilizers on concentration and uptake of nutrients by okra on lateritic soils of Konkan at College of Agriculture, Dapoli during *kharif* 1999. The results revealed that the application of FYM @ 7.50 t ha^{-1} recorded higher total N (2.48 %), P (0.52 %) and K (3.10 %) over vermicompost applied @1.5 t ha^{-1} and no manure in fruits of okra besides recording higher uptake of N (437.80 mg plant^{-1}), P (72.40 mg plant^{-1}) and K (370.30 mg plant^{-1}) by okra.

A field experiment was conducted by Kanan *et al.* (2006) during December- May (2003-04) with Tomato var. PKM 1 as test crop in Agriculture College and Research Institute, Madurai to study the influence of different organic N sources viz., FYM, vermicompost and coir pith compost with three levels (50, 75, and 100%) and azosprillum 2 kg^{-1} was included in 50 and 75% levels in all combinations and revealed that application of 75% N as vermicompost with Azosprillum registered high macronutrient as well as micronutrient content of tomato (9.0, 8.3 and 58.1% N:P:K respectively) and (169, 335, 232 and 326% Fe, Mn, Cu, and Fe respectively) compared to rest of the treatments.

Tambe *et al.* (2015) conducted a field experiment on effect of integrated nutrient management on yield, quality improvement and nutrient uptake of chilli at experimental farm at Department of Soil Science and Agricultural Chemistry, V. N. M. K. Vidyapeeth, Parbhani during *kharif* season using chilli crop with variety Pusa Jwala. Results revealed that the concentration of nutrients viz. nitrogen (2.49 per cent), phosphorus (0.23 per cent) and potassium (1.91 per cent) were found highest in chilli due to application of 50% RDF + 2.5 t ha^{-1} vermicompost + 2 sprays of vermiwash.

2.4 Effect of different sources of organic manures and their combination on uptake of nutrient by chilli plant

Mallangouda *et al.* (1995) at Dharwad (Karnataka) carried out an experiment on growth, yield and yield components of chilli cv. 'Bellary Red'. The highest uptake of N (62.68 kg ha^{-1}), P (8.36 kg ha^{-1}) and K (37.28 kg ha^{-1}) was observed in the 50% recommended dose of NPK + FYM treatment.

Ismail *et al.* (1997) working with chilli cv.'Pusa Jwala' recorded maximum uptake of N (22.34 kg ha^{-1}) when FYM and urea was combined i.e. 75 kg N ha^{-1} through FYM + 75 kg N ha^{-1} through urea. Phosphours (2.84 kg ha^{-1}) and potassium (8.79 kg ha^{-1}) uptake had also similar pattern as that of N.

Chavan *et al.* (1997) studied the effect of three nitrogen levels 90, 120 and 150 kg ha^{-1} through FYM and urea on yield uptake of nutrients and ascorbic acid content of chilli and recorded that the uptake of nutrients by chilli plants was maximum when combination of FYM and urea i.e. 75 kg N ha^{-1} through FYM+ 75 kg N ha^{-1} through urea, phosphorus and potassium uptake has similar pattern.

Talshilkar *et al.* (1997) studied the effect of poultry manure alone and in different combinations with inorganic fertilizers on yield, uptake of micronutrients and status of micronutrient in lateritic soils of Konkan and revealed that the total uptake of micronutrients such as Zn, Cu, Fe and Mn was increased significantly with increasing doses of fertilizers, poultry manure and their combinations.

Shashidhara (2000) recorded the uptake of nutrients *viz.*, NPK, Fe, Cu, Mn and Zn (at flowering and harvest) were significantly higher with combined application of organics (farm yard manure/BSS/red gram stalk) and inorganics (100% RDF/50% RDF). The combined application of 100% RDF with farm yard manure/BSS/red gram stalk also recorded significantly higher uptake for all nutrients as compared to 100 per cent RDF alone.

Harikrishna *et al.* (2002) conducted an experiment to study the effect of integrated nutrient management on availability and uptake of nutrients and yield of tomato during1999-2000 on sandy clay at Olericulture unit, College of Agriculture, Dharwad. Application of RDF (115:100:60 kg N:P2O5:K2O ha^{-1}) recorded higher uptake of N (74.73 kg ha^{-1}), P (15.58 kg ha^{-1}) and K (160.69 kg ha^{-1}) over FYM @ 25 t ha^{-1} (50.33, 11.06 and 123.94 kg ha^{-1} N, P and K, respectively). However, per cent N (1.25) and P (0.26) in tomato were maximum with RDF whereas, per cent K (2.81) was maximum with FYM @ 25 t ha $^{-1}$.

Dodala (2008) reported that the uptake of micronutrients viz. Fe, Mn, Zn and Cu by chilli was increased significantly due to substitution of RDN with organic sources of nutrients over RDF.

Naidu *et al.* (2009) conducted a field experiment in clayey textured soil on Typic Chromustert at main Agricultural Research Station, University of Agricultural Sciences, Dharwad during *kharif*, 2007 to study the effect of organic and inorganic sources of nutrients on nutrient uptake and residual fertility of of chilli (Cv. Byadgi Dabbi) in a vertisol. Results revealed that the highest uptake of major nutrients N (78.46 kg ha^{-1}), P (16.69 kg ha^{-1}), K (75.20 kg ha^{-1}) and micronutrients Viz., Zn (119.69 g ha-1), Fe (367.18 g ha^{-1}), Cu (48.91

g ha^{-1}), Mn (103.71 g ha^{-1}) were noticed with the application of 50 per cent RDN + 50 per cent N through FYM + BF + Panchagavya.

Hiraguli and Allolli (2012) conducted a field experiment on black soil at Regional Agricultural Research Station, Raichur during Rabi 2003, to study the response of chilli (cv. Byadagi Kaddi) to combined application of organic, inorganic and bio fertilizers. Results revealed that, uptake of nutrients viz. nitrogen (101.25 kg ha^{-1}), phosphorus (24.02 kg ha^{-1}) and potassium (126.37 kg ha^{-1}) were found highest when chilli was applied with FYM (25 t ha^{-1}) + RDF (100%). On the contrary, the lowest uptake of nutrients was observed in chilli when it was supplemented with FYM @ 25 t ha^{-1} + Azospirillum + PSB.

Tambe *et al.* (2015) conducted a field experiment on Effect of integrated nutrient management on yield, quality improvement and nutrient uptake of chilli at experimental farm at Department of Soil Science and Agricultural Chemistry, V. N. M. K. Vidyapeeth, Parbhani during *kharif* season using chilli crop with variety Pusa Jwala. Results revealed that the uptake of nutrients viz. nitrogen (41.98 kg ha^{-1}), phosphorus (3.87 kg ha^{-1}) and potassium (32.20 kg ha^{-1}) were found highest in chilli due to application of 50% RDF + 2.5 t ha^{-1} vermicompost + 2 sprays of vermiwash.

2.5 Effect of organic and inorganic sources of fertilizer in different combinations on quality of chilli

2.5.1 Capsaicin content

Subbiah *et al.* (1980) conducted an experiment to study the influence of different level of nitrogen, phosphorus and potassium on the capsaicin content of MDU-1 chilli and found that the capsaicin content of MDU-1 chilli was significantly influenced by the different levels of nitrogen, phosphorous and potassium. The treatment 80-0-35 (N P K kg ha^{-1}) recorded highest capsaicin content followed by 40-

0-35 (N P K kg ha^{-1}), the capsaicin content was lowered in plots without K.

Marry and Balakrishnan (1990) conducted the field experiment on effect of irrigation and potassium on pod characters and quality of chilli (*Capsicum annuum* L.) cv. K.2 with three nitrogen levels (52.5, 70.0 and 87.5 kg ha^{-1}) and three potassium levels (17.5, 35.0 and 52.5 kg ha^{-1}) at College of Agriculture and Research Institute, Madurai and revealed that nitrogen at 87.5 kg ha^{-1} recorded the highest capsaicin content in dry pods 118.02 mg100 g^{-1}. Among the different potassium levels K at 52.5 kg ha^{-1} recorded the highest capsaicin content of dry pods 115.86 mg 100 g $^{-1}$.

Mujumdar *et al.* (2000) studied the effect of different potassium levels on quality of chilli and tomato in loamy sand at College of Agriculture, Jobner, Rajasthan with four levels of potassium 0, 30, 60, and 90 kg ha^{-1} and 120 kg N ha^{-1} and 50 kg P ha^{-1} with basal application of 25 t FYM ha^{-1} and revealed that application of 90 kg K_2O ha^{-1} recorded maximum capsaicin content in chilli fruits was recorded maximum (296.25 mg 100g^{-1}) whereas minimum (260 mg 100g^{-1}) under control.

Kasture (2001) reported that the capsaicin content of chilli (c.v. Konkan Kirti) fruits increased due to interaction effect of applied phosphorous and sulphur in lateritic soil and it ranges between 0.234 % to 0.253 %.

Anathi *et al.* (2004) conducted a field trial to find out the effect of potassium on quality of Chilli and revealed that potassium influenced quality attributes of chilli i.e. application of 75 kg K ha^{-1} recorded highest capsaicin content in chilli.

Ademoyegun *et al.* (2011) conducted field experiment at the National Horticultural Research Institute (NIHORT), Ibadan, to study the Effects of poultry dropping on the biologically active compounds in *capsicum annuum* L (var. Nsukka Yellow) and revealed that, there was an significantly increased in capsaicin content (38.1 and 51.4 mg g^{-1} dry weight) as the level of poultry manure increased.

Kokare (2013) conducted field experiment on comparative efficacy of different fertilizer briquettes and organic manures on chilli (*Capsicum annuum* L. cv. Pusa Jwala) in lateritic soils of Konkan and he found that the application of vermicompost showed highest capsaicin content (0.505 %) in chilli fruit.

Pariari and Khan (2013) conducted a field experiment on integrated nutrient management of chilli (*Capsicum annuum* L.) in Gangetic alluvial plains. With application of six organic manures namely cow dung manures, vermicompost, neem cake, poultry manures, phosphocompost and mustard cake in different combination with inorganic nitrogenous fertilizers (urea) at three levels (25%, 50% & 75%). They found that the highest content of capsaicin (114.20 mg/g) in fruit were recorded when plants were treated with 75%N from neem cake and 25%N from urea.

Jayanthi *et al.* (2014) conducted a field experiments during 2012 – 2013 on clay loam soil at Vallampadugai, Chidambaram, Cuddalore District in Tamil Nadu, to evaluate the efficacy of vermifertilizer (VF) on the soil quality characteristics, and on the yield and quality characteristics of chilli (*Capsicum annuum* L.) in comparison to inorganic fertilizers (NPK). VF (5 tons ha^{-1}) and VF supplemented with recommended dose of chemical fertilizer (RDCF) (120:60:30 kg.ha) (w/w) had significantly enhanced ($P<0.05$) Capsaicin % of chilli.

Dileep S. N. and S. Sasikala (2015) found that the application of 75% RDF along with humic acid @ 30 kg ha^{-1} was recorded highest content of capsaicin (0.79 %).

2.5.2 Ascorbic acid content

Chinnaswami and Mariakulandai (1966) in a trial with organic and inorganic manures on tomato cv. 'CO.1' found that combined application of FYM and inorganic mixture increased the ascorbic acid content and protein content as compared with groundnut cake and inorganic fertilizer alone. They also reported that keeping quality and storage life was better in combined application of FYM and inorganic mixture.

Lata and Singh (1993) was carried out an experiment at G.B. Pant University of Agriculture and Technology, Pantnagar, to study the effect of nitrogen levels (0, 60, 120, and 180 kg ha^{-1}) on growth, yield and quality of chilli and revealed that the ascorbic acid content of fresh pods was decreased by higher levels of nitrogen. Maximum ascorbic acid content was recorded at 60 kg N ha^{-1}.

Nanthakumar and Veeraragavathatham (1996) recorded significantly higher ascorbic acid content 14.69 mg 100 g^{-1} in the treatment in which FYM was applied as a source of nitrogen only than the other treatments

Chavan *et al.* (1997) studied the effect of three nitrogen levels 90, 120 and 150 kg ha^{-1} through FYM and urea on ascorbic acid content of chilli and revealed that Vitamin C content increased significantly up to second picking and there after slight decrease was observed at third picking. The highest ascorbic acid content (241.2 mg 100 g^{-1}) of chilli was noted in second picking in the treatment in which nitrogen was applied as 75 Kg N ha^{-1} through FYM + 75 Kg N ha^{-1} through urea indicating the role of nitrogen in enhancing the ascorbic acid content in chilli fruits.

Ademoyegun *et al.* (2011) conducted field experiment at the National Horticultural Research Institute (NIHORT), Ibadan, to study the Effects of poultry dropping on the biologically active compounds in *capsicum annuum* L (var. Nsukka Yellow) and revealed that, highest content of ascorbic acid (64.5 mg 100g^{-1}) was found in 5 ton ha^{-1} of poultry manure and lowest in 15 ton ha^{-1} of poultry dropping.

Kokare (2013) conducted field experiment on comparative efficacy of different fertilizer briquettes and organic manures on chilli (*Capsicum annuum* L. cv. Pusa Jwala) in lateritic soils of Konkan and he found that the maximum vitamin C content (78.33 mg 100 g^{-1}) in chilli fruit was recorded with application of poultry manure.

Pariari and Khan (2013) found that the highest content of ascorbic acid (177.7 mg 100 g^{-1}) in fruits were recorded when plants were treated with 75%N from neem cake and 25%N from urea.

Jayanthi *et al.* (2014) conducted a field experiments during 2012 – 2013 on clay loam soil at Vallampadugai, Chidambaram, Cuddalore District in Tamil Nadu, to evaluate the efficacy of vermifertilizer (VF) on the soil quality characteristics, and on the yield and quality characteristics of chilli (*Capsicum annum* L.*)* in comparison to inorganic fertilizers (NPK). VF (5 tons/ha) and VF supplemented with recommended dose of chemical fertilizer (RDCF) (120:60:30 kg.ha) (w/w) had significantly enhanced ($P<0.05$) ascorbic acid (mg 100 g^{-1}) content of chilli.

Samsangheile and Kanaujia (2014) found that the maximum vitamin C content (247.1 mg 100 g^{-1}) in chilli fruit were recorded with the conjoint application of 50% NPK + 50% FYM + bio fertilizers.

Singh *et al.* (2014) found that the maximum ascorbic acid content (1.62 mg g^{-1}) in chilli fruit was recorded with application of organics FYM (12.5t/ha) + Vermicompost (2.5 t ha^{-1}) + Biofertilizer (@2.5kg ha-1 Azospirillum + PSB.

Dileep S. N. and S. Sasikala (2015) found that the application of 75% RDF along with humic acid @ 30 kg ha^{-1} was recorded highest content of ascorbic acid (140.80 mg 100g^{-1}).

2.6 Effect organic and inorganic sources of fertilizer in different combination on change in chemical properties of soil

Lal and Mathur (1989) reported that the application of compost either alone or in combination with chemical fertilizers showed significant improvement in available Zn, Mn, Cu, and Fe as compared to control. Application of N, P_2O_5, and K_2O through chemical fertilizers also recorded increase in available micronutrients as compared to control.

Vermicompost contains appreciable quantities of major as well as minor plant nutrients and when applied to soil, vermicompost improved nutrient status of the soil (Kale and Bano, 1988; Kale *et al.* 1994).

Chavan *et al.* (1997) studied the effect of three nitrogen levels 90, 120 and 150 kg ha^{-1} through FYM and urea on yield uptake of nutrients and ascorbic acid content of chilli and recorded that the available N in soil at harvest was maximum (366.45 kg ha^{-1}) when combination of FYM and urea i.e. 75 kg N ha^{-1} through FYM+ 75 kg N ha^{-1} through urea were applied.

Talashilkar *et al.* (1997) conducted a field experiment on integrated use of fertilizers and poultry manure to groundnut crop at College of Agriculture, Dapoli during *rabi* 1995-1996 and revealed that application of 1, 2, and 3 t ha^{-1} of poultry manure resulted into an increase in available manganese and iron status of the soil by 4.22, 8.72, 13.30 ppm and 2.14, 3.61, 6.21 ppm respectively over no poultry manure treatment. It was also reported that application of fertilizer at 50 and 100 per cent RDF significantly reduced soil pH as compared to zero level of fertilizer in lateritic soils of Konkan. Incorporation of poultry manure resulted into significant increase in soil pH towards neutrality as compared to control treatment.

Tolanur and Badanur (2003) reported that there was no change in pH of soil due to the application of 100 per cent RDF through inorganics and 50 per cent RDF through inorganics + 50 per cent RDF through FYM. But, it was observed that a change in EC and increase in organic carbon (0.47 %) content of soil with the application of 50 per cent RDF through FYM and 50 per cent RDF through fertilizer compared to 100 per cent RDF through inorganics alone (0.44 %).

Hangare *et al.* (2004) conducted a field experiment on influence of vermicompost and other organics on fertility and productivity of soil under chilli-spinach cropping system and opined that application of vermicompost and conditioner alone and in combination decreased the pH of soil from 8.35 to 7.70 similarly EC was reduced from 0.79 to 0.70 dSm^{-1}. But the initial stage organic carbon 0.93% was increased up to 1.37% after harvest.

Rajshree *et al.* (2005) reported that the application FYM increased the organic carbon content of soil when applied @ 7.50 t ha^{-1} along with 50 kg ha^{-1} nitrogen and 30 kg ha^{-1} phosphorus. Organic carbon content increased to 6.20 g kg^{-1} from an initial value (4.81 g kg^{-1}). It was also reported that the chemical properties of soil did not differ significantly due to the integrated nitrogen management. However, a higher organic carbon (7.80 g kg^{-1}) was recorded in treatment receiving 100 per cent RDN through FYM.

Ghuman and Sur (2006) reported that application of FYM @ 18 t ha^{-1} recorded higher organic carbon content (3.30 g kg^{-1}) and lower pH (7.3) over FYM applied @ 6 t ha^{-1} (2.9 g kg^{-1} and 7.4, organic carbon and pH, respectively) and control (1.7 g kg^{-1} and 7.5 organic carbon and pH, respectively) besides increasing yield of crops.

Manjunatha B. (2006) conducted an experiment to study the impact of farmers organic farming practices on soil properties in Northern dry zone of Karnataka in selected major cropping systems *viz.,* cotton, sugarcane, jowar and vineyard. FYM (varied from 8.0 to20.0 t $ha^{-1}year^{-1}$) and vermicompost (varied from 1.0 to 3.0 t ha^{-1} $year^{-1}$) were the sources of organics used in the study area. Results revealed that the soils under organic farming recorded higher amounts of available major nutrients *viz.,* N, P, K and S as well as micronutrients *viz.,* Zn, Fe, Mn and Cu than the soils under conventional farming in all the cropping systems.

Pandey *et al.* (2006) reported that application of manures irrespective of sources and rates, recorded significantly higher soil organic carbon, available N, P_2O_5 and K_2O compared to control. Higher content of organic carbon may be due to increased yields of roots and plant residues, and external application of organic manures.

Ullah *et al.* (2008), was conducted a field experiment at the Horticultural Farm of Bangladesh Agricultural University (BAU), Mymensing to evaluate the effect of manures and fertilizers on the yield of brinjal. Results revealed that the soil pH decreased with organic manures application and combined application but increased with only chemical fertilizer application. The highest availability of total N (1.17%) was found by combined application i.e. 20% cow dung + 20% mustard oilcake + 20% poultry manure + 40% N+ P +K fertilizers and highest availability of P (14.91ppm) was found from poultry manure and the highest availability of K (0.17 me $100g^{-1}$) was found from cow dung application.

Naidu *et al.* (2009) conducted a field experiment in clayey textured soil on Typic Chromustert at main Agricultural Research Station, University of Agricultural Sciences, Dharwad during *kharif*, 2007 to study the effect of organic and inorganic sources of nutrients on nutrient uptake and residual fertility of chilli (Cv. Byadgi Dabbi) in a vertisol. Results revealed that the highest available major nutrients N (324.9 kg ha^{-1}), P (29.7 kg ha^{-1}) and micronutrients, Zn (0.63 mg kg^{-1}), Fe (3.88 mg kg^{-1}), Cu (0.68 mg kg^{-1}) and Mn (2.94 mg kg^{-1}) were noticed with the application of 50 per cent RDN + 50 per cent N through FYM + BF + Panchagavya.

Kokare (2013) conducted field experiment on comparative efficacy of different fertilizer briquettes and organic manures on chilli (*Capsicum annuum* L. cv. Pusa Jwala) in lateritic soils of Konkan and he reported that the application of poultry manure recorded the maximum pH at all stages similarly, organic carbon content in soil was increased with application of organic manures and highest organic carbon content (19.97 g kg^{-1}) was recorded with application of poultry manure.

Jayanthi *et al.* (2014) conducted a field experiments during 2012 – 2013 on clay loam soil at Vallampadugai, Chidambaram, Cuddalore District in Tamil Nadu, to evaluate the efficacy of vermifertilizer (VF) on the soil quality characteristics, and on the yield and quality characteristics of chilli (*Capsicum annuum* L.*)* in comparison to inorganic fertilizers (NPK). VF (5 tons ha^{-1}) and VF supplemented with recommended dose of chemical fertilizer (RDCF) (120:60:30 kg.ha) (w/w) had significantly ($P<0.05$) increased the organic carbon, available N, P, K, other micro-macro nutrients – Ca, Mg, Na, Fe, Mn, Zn, Cu and reduced pH and EC in the field soil.

Samsangheile and Kanaujia (2014) conducted Experiment during *rabi* seasons 2010-2011 at Nagaland to find out the effect of integrated nutrient management on growth, yield and quality of chilli (*Capsicum annum* L.) and fertility status of soil under foothill condition of Nagaland. Results revealed that the Maximum available nitrogen (320.6 kg ha^{-1}) was recorded with application of 100% NPK fertilizer and maximum available P_2O_5 (13.4 kg ha^{-1}), K_2O (245.0 kg ha^{-1}), soil organic carbon (22.2 g kg^{-1}) and soil pH (4.90) were recorded with application of 50 % NPK + 50 % FYM + bio fertilizers.

Maheswari *et al.* (2015) conducted a field experiment on studies the efficacy of combined inoculation of different organic manures and azospirillum bio inoculant in solarized hot pepper nursery at Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu. The results of the experiment revealed that the slightly decrease in pH (6.85) and increase in the organic carbon (0.55 %), EC (0.61 dsm^{-1}) and phosphorus (43.10 kg ha^{-1}) was registered in plots that were solarized with vermicompost whereas the availability of nitrogen was found to be maximum (250.66 kg ha^{-1}) in plots that were solarized with groundnut cake and the available potassium (353.06 kg ha^{-1}) was highest in the plots that were solarized with neem cake.

Tambe *et al.* (2015) conducted a field experiment on Effect of integrated nutrient management on yield, quality improvement and nutrient uptake of chilli at experimental farm at Department Soil Science and Agricultural Chemistry, V. N. M. K. Vidyapeeth, Parbhani during *kharif* season using chilli crop with variety Pusa Jwala. Results revealed that, the pH (8.26 to 7.10) and EC (0.31 to 0.26 dsm^{-1}) of soil was decreased due to application of organic sources (vermicompost, vermiwash, cowdung urine slurry, EM culture) and also the organic carbon content in soil was significantly increased (0.37 to 0.63 per cent) when vermicompost was applied in combination with chemical fertilizer, cow-dung urine slurry and other organics.

CHAPTER III

MATERIAL AND METHODS

The present investigation pertaining to the studies on the "Effect of different sources of organic manures and their combination on yield and nutrient uptake by chilli (*Capsicum annum* L.) Cv. Konkan Kirti in lateritic soils of Konkan" was conducted during 2014-2015 at Vegetable Improvement Scheme, Pangari Block, Wakawali. The analytical work was done in the research laboratory of the Department of Soil Science and Agricultural Chemistry, College of Agriculture, Dapoli. The details regarding material used and methods followed during the course of investigation are presented in this chapters.

3.1 Material

3.1.1 Experimental site

A field trial was laid out at Vegetable Improvement Scheme, Pangari Block, Central Experimental Station, Wakavali, Tahsil-

Dapoli, and Dist. - Ratanagiri. The selection of site was done on the basis of suitability of land for the cultivation of chilli where, the facilities of irrigation water and protection from cattle's were available.

3.1.2 Climate and Weather

The Central Experiment Station, Wakawali is situated in the tropical region on 17^{0}40' to 17^{0}45'N and 73^{0}16' to 73^{0}19'E. The height above mean sea level is 167 m to 234 m. The climate is hot, humid with well-expressed three seasons *viz.*, summer (March to May), rainy (June to October) and winter (November to February). The region receives very high rainfall (above 3000 mm, annually). The weather data recorded at Meteorological observatory, Central Experiment Station, Wakawali during the crop growth period is mentioned in Table 1.

Table 1: The weather parameters recorded at Meteorological Observatory, CES, Wakawali during *Rabi* season of 2014 - 15

Period	**Temp. (^{0}C)**		**Relative humidity (%)**		**Sun Shine (hrs. day^{-1})**	**Rainy Day**
	Max.	**Min.**	**Mor.**	**Eve.**		
01-Jan-15 to 07-Jan-15	26.7	13.1	78.14	72.71	6.90	0
08-Jan-15 to 14-Jan-15	26.7	11.1	80.86	66.29	8.34	0
15-Jan-15 to 21-Jan-15	26.4	10.9	78.14	68.71	8.09	0
22-Jan-15 to 28-Jan-15	27.9	13.8	76.71	69.71	7.91	0
29-Jan-15 to 04-Feb-15	27.7	12.7	84.57	66.57	8.13	0
05-Feb-15 to 11-Feb-15	28.6	11.3	86.29	65.43	8.69	0
12-Feb-15 to 18-Feb-15	27.2	12.8	76.14	61.00	8.66	0
19-Feb-15 to 25-Feb-15	27.6	13.2	69.29	68.29	8.60	0
26-Feb-15 to 04-Mar-15	27.9	15.4	68.57	70.43	7.60	2
05-Mar-15 to 11-Mar-15	28.2	17.0	72.71	74.14	8.47	0

12-Mar-15 to 18-Mar-15	29.6	17.6	72.57	62.00	8.20	0
19-Mar-15 to 25-Mar-15	28.6	16.3	76.14	73.14	7.11	0
26-Mar-15 to 01-Apr-15	29.4	18.8	78.14	81.00	6.24	0
02-Apr-15 to 08-Apr-15	28.3	17.2	74.29	76.00	7.36	0
09-Apr-15 to 15-Apr-15	27.7	18.9	84.14	76.57	7.37	0
16-Apr-15 to 22-Apr-15	28.9	21.1	77.71	77.00	7.59	0
23-Apr-15 to 29-Apr-15	28.9	19.82	83.75	83.86	8.61	0
30-Apr-15 to 06-May-15	28.9	20.5	86.70	90.60	9.3	0
07-May-15 to 13-May-15	29.63	22.3	84.29	85.00	7.84	0
14-May-15 to 20-May-15	28.9	20.4	82.10	69.70	7.9	0
21-May-15 to 27-May-15	30.0	20.4	77.10	57.40	9.3	0
28-May-15 to 03-June-15	28.63	20.3	82.43	67.57	8.71	0
04-Jun-15 to 10-June-15	28.9	20.1	80.0	68.4	4.8	3
11-Jun-15 to 17 June-15	27.9	20.3	84.3	77.4	2.3	2

3.1.3 Soil

The field experiment was conducted in the soil having loamy skeletal, mixed, isohyperthermic shallow typic Ustohrepts. To know the initial soil fertility status of experimental plot, a representative composite surface soil sample was collected from 0-15 cm depth on 03.01.2015 by following the standard method of soil sample collection.

The collected soil samples were processed in laboratory for analysis by removing admixtures, followed by air drying in clean ventilated room. Then these samples were grounded in wooden mortar and sieved through 2.0 mm sieve and also through 0.5 mm sieve for special determination like organic carbon. After processing, the samples were stored in properly labeled corrugated boxes and used for determination of major nutrients (N, P, K), DTPA extractable micronutrient (Fe, Mn, Zn and Cu), and various physico-chemical properties of soil.

The initial experimental soil was sandy clay loam in texture, slightly acidic in reaction and low in electrical conductivity. The soil was to be found very high in organic carbon and was low in available N and P_2O_5. The soil was high in available K_2O. DTPA extractable micronutrients (Fe, Mn, Zn and Cu) were found to be 28.86, 114.0, 0.372 and 2.752 (mg kg^{-1}), respectively.

Table 2: Initial physico - chemical properties of soil

1	**Physico – chemical properties**	
	I) Mechanical Analysis	
	a) Sand (%)	63.12
	b) Silt (%)	17.19
	c) Clay (%)	19.69
	d) Texture class	Sandy clay loam
	II) Particle density (Mg m^{-3})	2.58
	III) Bulk density (Mg m^{-3})	1.54
	IV) Porosity (%)	45.38
	V) Maximum water holding capacity (%)	49.02
2	**Chemical properties**	
	VI) pH (1 : 2.5)	5.29
	VII) Electrical conductivity (dSm^{-1})	0.33
	VIII) Organic Carbon (%)	1.68
	IX) Available N (kg ha^{-1})	215.8
	X) Available P_2O_5 (kg ha^{-1})	11.87
	XI) Available K_2O (kg ha^{-1})	315.29
	XII) DTPA extractable Fe (mg kg^{-1})	28.86
	XIII) DTPA extractable Mn (mg kg^{-1})	114.0
	XIV) DTPA extractable Zn (mg kg^{-1})	0.372
	XV) DTPA extractable Cu (mg kg^{-1})	2.752

3.1.4 Crop

Chilli (*Capsicum annuum* L.) var. Konkan Kirti was taken as a test crop during Rabi season of the year 2014 -2015 with a spacing 60 X 45 cm.

3.1.5 Experimental Details

3.1.5.1 Layout of the experiment

The field experiment was laid out in a randomized block design comprising of twelve treatments with three replications. Gross plot size was 3m × 2.4 m, the plan of field layout along with treatment details is given in (Fig.1)

1)	Soil type	:	Lateritic soil
2)	Year and season	:	*Rabi,* 2014-15
3)	Test Crop	:	Chilli
4)	Variety	:	Konkan Kirti
5)	Number of treatments	:	13
6)	Number of replications	:	Three
7)	Total number of plots	:	39
8)	Design of experiment	:	Randomized Block Design.

3.1.5.2 Details of treatment

There were thirteen treatment combinations in three replications. The details are presented in Table 3.

Table 3: The details of the treatments

Treatment No.	Description of treatment
T_1	25% N(FYM) + 75% N(Urea)
T_2	50% N(FYM) + 50% N(Urea)
T_3	75% N(FYM) + 25% N(Urea)
T_4	25% N(VC) + 75% N(Urea)
T_5	50% N(VC) + 50% N(Urea)
T_6	75% N(VC) + 25% N(Urea)

T_7	25% N(PM) + 75% N(Urea)
T_8	50% N(PM) + 50% N(Urea)
T_9	75% N(PM) + 25% N(Urea)
T_{10}	25% N(GC) + 75% N(Urea)
T_{11}	50% N(GC) + 50% N(Urea)
T_{12}	75% N(GC) + 25% N(Urea)
T_{13}	Absolute control

- FYM- Farm yard manure. (Applied on N content Based)
- VC- Vermicompost. (Applied on N content Based)
- PM- Poultry manure (Applied on N content Based)
- GC- Groundnut cake (Applied on N content Based)

Note:

1. FYM, Poultry Manure, Vermicompost and Groundnut cake was applied 10 days before transplanting.
2. Half dose of N and recommended dose of P and K was applied at the time of transplanting and half dose of N was applied at 30 days after transplanting.

Table 4: Nutrient content in various fertilizers and organic manures

Sr. No.	Fertilizers and organic manures	Nutrient content (%)		
		N	**P_2O_5**	**K_2O**
1.	Urea	46.0	-	-
2.	Single super phosphate	-	16.0	-
3.	Muriate of potash	-	-	60.0
4.	FYM	0.62	0.2	0.5
5.	Vermicompost	1.12	1.2	1.5
6.	Poultry manure	2.60	2.04	1.4
7.	Groundnut cake	6.72	1.50	1.8

3.1.5.3 Details of cultivation

1. Raising of seedlings

The seeds of chilli (Konkan Kirti) were sown on 20th December 2014 on raised beds by following usual practice. The chilli seedlings were grown for a period of 34 days. The chilli seedlings were uprooted on 23rd January 2015 and were used for transplanting.

2. Preparation of field

Preparatory tillage operations consisting of one ploughing before application of organic manures, harrowing and planking combined (one) were carried out prior to the layout of the experiment. After the layout of field, the plots were prepared as per the plan of layout.

3. Application of organic manures

Organic manures, viz. Farm yard manure, Vermicompost, Poultry manure and groundnut cake was applied on the basis of nitrogen content only, and applied at the time of field preparation. The composition of organic fertilizers used in the present study is given in Table 4.

3. Transplanting of seedlings

After preparation of field, seedlings were transplanted @ one healthy seedling per hill on 23rd January 2015 with spacing 60 cm x 45 cm.

4. Application of fertilizers

The plant nutrients were applied through fertilizer *viz.*, urea, single super phosphate and muriate of potash for N, P and K, respectively .Nitrogen @ 100 kg ha^{-1} was applied in two splits *viz.,* first dose 1/2 was applied at transplanting and second dose 1/2 dose at 30 days after transplanting. Phosphorus at 50 kg ha^{-1} and potassium 50 kg ha^{-1} were applied in single dose at the time of transplanting. The composition of inorganic fertilizers used in the present study are given in Table 4.

3. Cultural operations

The various cultural operations were undertaken as and when required, the details regarding cultural operations and their dates as well as collection of plant soil and plant samples are given in Table 5.

4. Biometric observations

In order to study the effect of various treatments on the growth parameters, yield contributing characters, yield, nutrient content and uptake of nutrient by chilli and nutrient availability in soil, pertinent observations were recorded from time to time.

For recording biometric observations five plants from each treatment plot wise were randomly selected, the selected plants were labeled with proper notations. One plant from each treatment plot were uprooted other than selected plant from each treatment plot were randomly selected.

3.2.1 Sampling techniques

The soil samples were collected from each treatment plot at 30, 60 DAT and at harvest stage for different nutrient analysis.

Table 5: Schedule of cultural operations performed during crop growth period

Sr. No.	Field operations	Frequency	Date
1.	**Preparatory tillage**		
	i) Ploughing	1	03/01/2015
	ii) Harrowing	1	05/01/2015
2.	**Nursery preparation**		
	i) Preparation of beds	1	19/12/2014
	ii) Sowing	1	20/12/2014
	iii) Uprooting of seedling	1	23/01/2015
3.	**Field operations**		
	i) Initial soil sample collection	1	03/01/2015
	ii) Layout of experimental plot	1	07/01/2015
	iii) Application of FYM, Vermicompost, Poultry manure and groundnut cake according	1	09/01/2015

	to treatment.		
	iv) Transplanting	1	23/01/1015
	v) Application of fertilizers, 1/2 dose of Nitrogen and full dose of P_2O_5 and K_2O.	1	23/01/1015
	vii) Application of 1/2 dose of Nitrogen	1	25/02/2015
	viii) Hand weeding	2	24/02/2015 07/04/2015
	ix) Irrigation : Number of irrigations	9	From 23/01/2015 To 16/06/2015 At 8-10 days interval.
4.	**Plant protection measures**		
	Spraying of fungicide (Mancozeb 2.5 gm/lit) Spraying of insecticide (Spinosad 45%SC).	2	07/04/2015 05/05/2015
5.	**Collection of soil and plant samples**		
	a) Soil sampling		
	i) Soil sampling at 30 DAT	1	23/02/2015
	ii) Soil sampling at 60 DAT	1	25/03/2015
	iv) Soil sampling at harvesting	1	16/06/2015
	b) Plant sampling		
	i) Plant sampling at 30 DAT	1	23/02/2015
	ii) Plant sampling at 60 DAT	1	25/03/2015

	iv) Plant sampling at harvest	1	16/06/2015
6.	**Harvesting**	6	From 04/04/2015 To 16/06/2015 At maturity of green chilli pods
7.	**Recording yield data**		
	i) Pod yield	6	From 04/04/2015 To 16/06/2015 At maturity of pods
	ii) Straw yield	1	17/06/2015

3.2.2 Growth parameters

The details in respect of various biometric and other observations recorded during the course of study are presented in Table 6.

3.2.2.1 Plant height (cm)

Plant height was recorded from selected plant and then the average was worked out. Height of plant was measured in centimeters from the ground level to the tip of fully opened leaf.

3.2.3 Yield contributing characters

3.2.3.1 Weight of fruit (g plant^{-1})

Observation on weight of fruit (g plant^{-1}) was recorded from five selected plants in the plot area at each picking time and average was workout.

3.2.3.2 Yield of the crop (q ha^{-1})

Pods were harvested at maturity i.e. green matured chilli and the pod yield obtained after each harvesting and straw yield after uprooting of crop was recorded with fresh as well as dry straw yield.

Table 6: Biometric and other observations recorded

Sr. No.	Particulars	Frequency	Stages
A.	Growth and yield contributing characters		
i)	Plant height (cm)	Three time	At 30, 60 DAT and at harvest.
ii)	Weight of fruit (g plant-1)	Six time	Each harvesting
iii)	Pod yield (q ha^{-1})	Six time	Each harvesting
iv)	Straw yield (q ha-1)	One time	After harvesting
B.	Nutrient content and uptake studies of N, P, K, Fe, Mn, Zn and Cu.	Three time	At 30, 60 DAT and at harvest.
C.	Soil reaction, EC, organic carbon and changes in available N, P, K, Fe, Mn, Zn and Cu.	Three time	At 30, 60 DAT and at harvest.
D.	Quality parameters of pod i) Capsaicin content ii) Ascorbic acid content	 One time One time	 At harvest At harvest

3.2.4. Content and uptake of nutrients by chilli

Treatment wise plant samples were collected as mentioned earlier at 30, 60 DAT and at harvest stages. The samples were first washed with tap water and with deionized water and then were air dried and preserved in the brown paper bags labeled with permanent marker. These representative samples were dried in oven at a temperature of 60 ± 5°C and ground in Willey type grinding machine and stored in polythene bags for analysis. The samples were then analyzed to know the content and the uptake of nutrients was worked out using yield data.

3.2.5 Collection and preparation of soil samples

The representative surface soil samples (0–15 cm) were collected from each treatment plot at 30, 60, DAT and at harvest stage. Treatment wise composite soil samples were prepared by principle of quartering. The samples were air dried in shade, pounded in wooden mortar with pestle and sieved through 2 mm sieve. After processing, the samples were stored in properly labeled corrugated boxes and used for determination of various chemical properties in the laboratory by following the standard analytical methods.

3.3 Methods

3.3.1 Soil analysis

3.3.2.1 Soil physical properties

i) Particle size analysis

The soil separates such as sand, silt and clay in composite sample were estimated by Bouyoucos hydrometer method (Bouyoucos, 1951) and the textural class was determined with the help of textural triangle as outlined by Chopra and Kanwar (1978).

ii) Bulk density (Mg m^{-3})

Bulk density of the initial soil sample was determined using clod coating method described by Black (1965).

iii) Particle density (Mg m^{-3})

Particle density was estimated by using Pycnometer as described by Black (1965).

iv) Maximum water holding capacity

It was determined by using Keen-Raczkowski circular brass boxes as described by Piper (1966).

3.3.2.2. Soil Chemical properties

i) Soil reaction

The pH of soil was determined using pH meter having glass and calomel electrode using 1:2.5 soil: water suspension ratio (Jackson, 1973).

ii) Electrical conductivity

Electrical conductivity of soil was determined with the help of Systronic Conductivity Meter-306 using 1: 2.5 soil: water suspension ratio (Jackson, 1973).

iii) Organic carbon

It was determined by following Walkley and Black wet digestion method (Black, 1965).

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

Available nitrogen was determined by alkaline permangnate (0.32% $KMnO_4$) method (Subbiah and Asija, 1956).

v) Available phosphorus

Available phosphorus (Bray's P) was determined by extracting the acid soil P in dilute acid fluoride (Bray and Kurtz, 1945). Phosphorus in the extract was determined colorimetrically at 660 nm as described by Black (1965).

vi) Available potassium

It was estimated on Systronics Flame Photometer-128 using neutral-normal-ammonium acetate (NH_4OAc, pH 7.0) as per procedure given by Jackson (1973).

vii) DTPA extractable micronutrient (Fe, Mn, Zn and Cu).

DTPA extractable Fe, Mn, Zn and Cu were extracted from soil by Lindsay and Norvell (1978) method. The extracting solution used for this purpose consisted of 0.005 M DTPA (Diethylene Triamine Penta Acetic acid), 0.01 M $CaCl_2$ and 0.1 M TEA (Tri Ethanol Amine) buffered at pH 7.3 and concentration of these nutrients were determined with Atomic Absorption Spectrophotometer (Perkin Elmer make model no. AA2200).

3.3.3 Plant analysis

i) Total nitrogen

The plant samples were digested with conc. H_2SO_4 and the total nitrogen content was determined by using Pelican make Distyl Em distillation unit (Tondon, 1993).

ii) Total phosphorus, potassium.

For determination of P and K 1.0 g plant sample was digested with nitric and perchloric acid, the final volume was made to 100 ml with distilled water and P and K in extract was determined. (Singh *et al.*, 1999).

a) Phosphorus

It was determined by using known quantity of Di-acid extract as mentioned above and the yellow colour was developed with combined HNO_3 vanadomolybdate reagent. Phosphorus was determined colorimetrically by using spectrophotometer at 420 nm wavelength (Chopra and Kanwar, 1978).

b) Potassium

It was estimated flame photometrically by feeding diluted Di-acid digested solution duly diluted 10 times (Piper, 1966).

c) Micronutrient (Fe, Mn, Zn and Cu).

For determination of micronutrient 0.5 g plant sample was digested with Di-acid mixture of nitric and perchloric acid (9:4). After digestion volume was made to 50 ml, micronutrients was determined by using AAS. (Mclaren and Crawford, 1950).

3.3.4 Fruit analysis

a) Capsaicin content

The capsaicin content in dry green pods was estimated by colorimetrically using a spectrophotometer at 650 nm. (Quagliotti, 1971).

b) Ascorbic acid

The ascorbic acid content in green chilli pods was estimated by 2, 6-dichlorophenol indophenol dye method (Ranganna, 1977).

3.3.5 Statistical analysis

The experimental data was analyzed statistically by the technique of analysis of variance as applicable to randomized block design. The significance of treatment difference was tested by 'F' (Variance ratio) test. Critical difference (CD) at 5 per cent level of probability was worked out for comparison and statistical interpretation of the treatment means (Panse and Sukhatme, 1967).

CHAPTER IV

RESULTS AND DISCUSSION

In the present investigation, an attempt has been made to study "Effect of different sources of organic manure and their combination on yield and nutrient uptake by chilli (*Capsicum annuum* L.) in lateritic soil of Konkan" during the year 2014-15. The soil samples collected during the course of investigation were analyzed for chemical properties, while the plant and green chilli pod samples were assessed for their nutrient uptake by the crops and its quality. The results obtained during the present studies are presented and discussed in this chapter. For better understanding the experimental data have been grouped and presented under following heads:

Effect of different sources of organic manures and their combination on,

4.1 Effect on growth and yield contributing characters.

4.2 Effect on green chilli pod and Stover yield.

4.3 Effect on nutrient content in plant and green chilli pod.

4.4 Effect on uptake of nutrient by chilli plant.

4.5 Effect on quality of chilli.

4.6 Effect on chemical properties of soil.

4.1 Effect on growth and yield contributing characters.

4.1.1 Plant height:

The data pertaining to height is given in Table 7. It is observed that at 30 DAT, plant height ranged between 17.30 and 30.12 cm. and treatment difference were significant. Treatment T_9, receiving 75 % N through poultry manure and 25 per cent N through urea recorded significantly highest plant height (30.12cm) amongst the treatments, which was found at par with T_2, T_5, T_6, T_8, T_{10}, T_{11} and T_{12}.

At 60 DAT, the plant height ranged between 28.20 and 44.53 cm. the treatment differences were not significant. Treatment T_9, receiving 75 % N through poultry manure and 25 per cent N through urea recorded highest plant height (44.53 cm) amongst the various treatments.

Table 7: Effect of different sources of organic manures and their combination on growth and yield contributing characters.

Tr. No.	Treatment Details	Plant Height (cm)			Weight of fruit (g plant^{-1})
		30 DAT	60 DAT	At harv.	
T_1	25% N(FYM) + 75% N(Urea)	24.89	34.67	40.51	267.44
T_2	50% N(FYM) + 50% N(Urea)	26.29	37.67	41.20	271.50
T_3	75% N(FYM) + 25% N(Urea)	25.52	39.70	43.92	308.54
T_4	25% N(VC) + 75% N(Urea)	25.06	39.20	45.72	275.15
T_5	50% N(VC) + 50% N(Urea)	27.13	36.07	43.07	298.13
T_6	75% N(VC) + 25% N(Urea)	27.63	36.47	42.23	299.32
T_7	25% N(PM) + 75% N(Urea)	25.35	39.40	44.73	308.08
T_8	50% N(PM) + 50% N(Urea)	27.77	40.13	47.47	345.63
T_9	75% N(PM) + 25% N(Urea)	30.12	44.53	48.76	300.47
T_{10}	25% N(GC) + 75% N(Urea)	26.70	37.80	44.47	289.71
T_{11}	50% N(GC) + 50% N(Urea)	26.94	40.13	48.15	284.80
T_{12}	75% N(GC) + 25% N(Urea)	27.29	38.47	41.00	295.72
T_{13}	Absolute control	17.30	28.20	36.47	198.87
	SE ±	1.37	2.95	3.45	16.57
	C.D.(P=0.05)	4.00	NS	NS	48.37

At harvest, the plant height ranged between 36.17 and 48.76 cm. Treatment T_9 receiving 75 % N through Poultry manure and 25 per cent N through urea recorded highest plant height (48.76 cm) amongst the treatments but it was found statistically non-significant. Similar results was also found by Masud *et al.* (2009) and reported that Pepper height increased with increase in poultry manure rates. Poultry manure contains essential nutrient elements associated with high photosynthetic activities and thus promoted roots and vegetative growths (John *et al.*, 2004). The increase in poultry manure rate increased the plant height. This could be attributed to improved soil conditions (moisture retention, soil structure and aeration and increase nitrogen availability) following the poultry manure application. The increase in vegetative growth in treatments that received high poultry manure rate could be due to high nitrogen content (Frank, 1965).

Application of plant nutrients through various sources of organic manures combined with inorganic fertilizers increased the plant height significantly at 30 DAT, but plant height at 60 DAT and at harvest did not reach the levels of significance due to several treatments. Such increase in plant height vis-à-vis increasing dose of N through combination of organic and inorganic sources were also reported by Ikeh *et al.* (2012), Shashidhara and Shivamurthy (2008), Chavan *et al.* (1997), Pariari and Khan (2013), and Rani *et al.* (2015)

4.1.2 Weight of fruit (g plant^{-1})

The data pertaining on the yield contributing characters i.e. weight of fruit per plant is given in Table 7.which reveals that weight of fruit per plant were significantly influenced due to application of various sources of manures and their combination.

The fresh fruit weight was remarkably maximum (345.63 g plant^{-1}) in treatment T_8 receiving 50 % N through poultry manure and 50 per cent N through urea, which was found to be significantly higher over other treatments except treatments T_3, T_5, T_6, T_7 and T_9 which was found at par with T_8. Minimum fruit weight (198.87 g plant^{-1}) was recorded in treatment T_{13} (Absolute control). The results of the present study are in agreement with those reported by Masud *et al.* (2009) who reported that the maximum weight of fruit (g plant^{-1}) was recorded in plots receiving 100 per cent STB (Soil test base) + 2.5 ton poultry manure ha^{-1}.

4.2 Effect on chilli pod and Stover yield.

The data pertaining pod and stover yield of chilli as influenced by different treatments are presented in Table 8 and depicted in Fig 2.

4.2.1 Effect on green chilli pod yield

The application of different sources organic manure and their combination with inorganic fertilizers significantly influenced the yield of green chilli.

Table 8: Effect of different sources of organic manures and their combination on yield of chilli.

Tr. No.	Treatment Details	Yield (q ha^{-1})		
		Green pod yield	Dry matter yield of green pods	Stover yield
T_1	25% N(FYM) + 75% N(Urea)	99.05	8.88	15.03
T_2	50% N(FYM) + 50% N(Urea)	100.56	9.81	10.96
T_3	75% N(FYM) + 25% N(Urea)	114.27	9.71	12.13
T_4	25% N(VC) + 75% N(Urea)	101.91	8.72	12.36
T_5	50% N(VC) + 50% N(Urea)	110.42	10.16	11.23
T_6	75% N(VC) + 25% N(Urea)	110.86	10.27	9.25
T_7	25% N(PM) + 75% N(Urea)	114.10	10.40	11.86
T_8	50% N(PM) + 50% N(Urea)	128.01	11.22	15.28
T_9	75% N(PM) + 25% N(Urea)	111.28	9.24	12.99
T_{10}	25% N(GC) + 75% N(Urea)	107.30	9.49	10.91
T_{11}	50% N(GC) + 50% N(Urea)	105.48	9.68	12.15
T_{12}	75% N(GC) + 25% N(Urea)	109.53	11.08	9.50
T_{13}	Absolute control	73.65	5.73	8.13
	SE ±	6.14	0.86	1.23
	C.D.(P=0.05)	17.91	2.52	3.60

The application of different sources of organic manures and their combination on chilli significantly influenced the yield of green chilli as well as stover. Highest green pod yield of chilli (128.01 q ha^{-1}) was recorded in the treatment T_8 receiving 50 % N through Poultry manure and 50 per cent N through urea, which was found significantly higher over rest other treatments except the treatment T_3 (114.27 q ha^{-1}), T_5 (110.42 q ha^{-1}), T_6 (110.86 q ha^{-1}), T_7 (114.10 q ha^{-1}) and T_9 (111.28 q ha^{-1}) which were statistically at par. The lowest yield (73.65 q ha^{-1}) was recorded in control treatment (T_{13}) which was least effective. The yield q ha^{-1} was recorded in lateritic soils of Konkan is in agreement with Kasture (2001) and Kokare (2013).

4.2.2 Effect on Dry matter yield of green chilli pod

The data presented in Table 8 shows that dry pod yield of chilli is significantly influenced by various treatments and ranged between 11.22 q ha^{-1} to 5.73 q ha^{-1}. Maximum dry matter of green pod yield (11.22 q ha^{-1}) was recorded in treatment T_8 receiving 50 % N through poultry manure and 50 per cent N through urea, which was significantly higher over the rest of treatment and except treatment T_{13} all treatments were found to be at par. The treatment not receiving any fertilizer or manure T_{13} i.e. control was less effective by recording minimum dry matter of green pod yield. Range of the yield recorded here was similar with the results obtained by Mujumdar *et al.* (2000), Kasture (2001) and Kokare (2013)

4.2.3 Effect on stover yield of chilli.

Stover yield of chilli was found to be a significant. Numerically higher stover yield (15.28 q ha^{-1}) was obtained by treatment T_8 receiving 50 % N through Poultry manure and 50 per cent N through urea, which was significantly higher over the rest of treatment and treatment T_1, T_3, T_4, T_7, T_9 and T_{11} was found to be at par. The lowest stover yield (8.13 q ha^{-1}) was recorded in treatment T_{13} (Absolute control).

4.3 Effect on nutrient content in plant and green chilli pod.

Data pertaining to the content of N, P, K, Fe, Mn, Zn and Cu in parts of chilli plant (i.e. 30, 60 DAT and at harvest) and in pod at harvest as affected by different treatments have been presented in Table 9 to 15.

4.3.1 Effect on nitrogen content

Effect of different sources of organic manures and their combination on nitrogen content in chilli at different growth stages of a crop is represented in Table 9.

4.3.1.1 Nitrogen content in chilli plant

The nitrogen content in chilli plant at 30DAT was significantly influenced by the various treatments. It varied from 1.06 to 1.98 per cent in all treatments. Maximum N content (1.98%) was found in treatment T_8 (50 N through poultry manure + 50 % N through Urea) which was significantly highest over rest of the treatments except treatment T_6, T_9 which was at par with this treatment.

Table 9: Effect of different sources organic manures and their combination on Nitrogen content in plants at different stages and pod.

Tr. No.	Treatment Details	Total Nitrogen (%)			
		30 DAT	60 DAT	At harvest	Pod
T_1	25% N(FYM) + 75% N(Urea)	1.32	1.43	1.18	1.41
T_2	50% N(FYM) + 50% N(Urea)	1.44	1.46	1.31	1.30
T_3	75% N(FYM) + 25% N(Urea)	1.29	1.38	1.25	1.44
T_4	25% N(VC) + 75% N(Urea)	1.35	1.57	1.20	1.39
T_5	50% N(VC) + 50% N(Urea)	1.51	1.95	1.30	1.54
T_6	75% N(VC) + 25% N(Urea)	1.89	2.06	1.29	1.46
T_7	25% N(PM) + 75% N(Urea)	1.50	1.76	1.32	1.38
T_8	50% N(PM) + 50% N(Urea)	1.98	2.16	1.43	1.68
T_9	75% N(PM) + 25% N(Urea)	1.73	1.99	1.40	1.37
T_{10}	25% N(GC) + 75% N(Urea)	1.62	2.07	1.36	1.36
T_{11}	50% N(GC) + 50% N(Urea)	1.33	1.67	1.19	1.53
T_{12}	75% N(GC) + 25% N(Urea)	1.43	1.91	1.33	1.40
T_{13}	Absolute control	1.06	1.21	1.11	1.21
	SE ±	0.10	0.13	0.06	0.80
	C.D.(P=0.05)	0.30	0.39	0.18	0.22

The nitrogen content at 60 DAT was increased from 1.57 to 2.16 per cent; the highest N content (2.16%) was found in treatment T_8 (50 N through poultry manure + 50 % N through Urea). Which was significantly highest over rest of the treatments and treatments T_5, T_6, T_7, T_9, T_{10} and T_{12} which was found at par with this treatment.

Nitrogen content in chilli plant at harvest was significantly influenced by various treatments. At harvest, N content ranged between 1.11 and 1.43 per cent. The highest N per cent (1.43%) was found in treatment T_8 (50 N through poultry manure + 50 % N through Urea) which was found significantly higher than all other treatments except T_1, T_2, T_{11}, T_{12} and T_{13} all treatments were found at par with this treatment.

Overall results indicated that the nitrogen content in chilli plant was maximum at 60 DAT and declined gradually from 60 DAT till harvest. Jones (1983) stated that concentration of nutrient in plant parts varies with age of crop.

The results of the present study are in agreement with those reported by Dodla (2008) and Kokare (2013) they reported that the higher N content in plant was recorded at flowering stage and then it decreased up to harvesting.

4.3.1.2 Nitrogen content in green chilli pod

The data pertaining to nitrogen content in green chilli is given in Table 9. It was observed that at harvest stage, the highest N content in pod (1.68%) was contributed by treatment T_8 receiving 50 per cent N through poultry manure and 50 per cent N through urea. Which was significantly highest over rest of the treatments except treatment T_5, T_6 and T_{11} which was at par with each other.

4.3.2 Effect on Phosphorus content

Effect of different organic manures and their combination on phosphorus content in chilli variety Konkan Kirti at different growth stages of crop is presented in Table 10.

4.3.2.1 Phosphorous content in chilli plant

The data pertaining to phosphorus content in chilli plant given in Table 10. It was observed that at 30, 60 DAT and at harvest was significantly affected due to various treatments and it ranged from 0.05 to 0.12 per cent at 30 DAT, 0.08 to 0.14 per cent at 60 DAT and 0.06 to 0.13 per cent at harvest.

At the 30 days after transplanting, maximum P content (0.12%) was found in the treatment T_5 (50 N through vermicompost + 50 % N through Urea) which was significantly higher over the rest of the treatments except treatment T_8, which was at par with this treatment.

At 60 DAT, the highest P content (0.14%) was found in treatment T_5 (50 N through vermicompost + 50 % N through Urea), which was significantly higher over the rest of the treatment. The treatments T_3, T_4, T_6 and T_8 were at par with each other and the lowest P content (0.08%) was found in treatment T_{13} (Absolute control).

Table 10: Effect of different sources of organic manures and their combination on phosphorus content in plants at different stages and pod.

Tr. No.	Treatment Details	Total Phosphorus			
		30 DAT	60 DAT	At harv.	Pod
T_1	25% N(FYM) + 75% N(Urea)	0.08	0.10	0.09	0.14
T_2	50% N(FYM) + 50% N(Urea)	0.08	0.11	0.10	0.16
T_3	75% N(FYM) + 25% N(Urea)	0.09	0.13	0.12	0.14
T_4	25% N(VC) + 75% N(Urea)	0.10	0.13	0.11	0.17
T_5	50% N(VC) + 50% N(Urea)	0.12	0.14	0.13	0.16
T_6	75% N(VC) + 25% N(Urea)	0.08	0.13	0.12	0.17
T_7	25% N(PM) + 75% N(Urea)	0.08	0.12	0.12	0.14
T_8	50% N(PM) + 50% N(Urea)	0.11	0.13	0.12	0.18
T_9	75% N(PM) + 25% N(Urea)	0.09	0.11	0.11	0.16
T_{10}	25% N(GC) + 75% N(Urea)	0.09	0.12	0.09	0.15
T_{11}	50% N(GC) + 50% N(Urea)	0.08	0.11	0.10	0.13
T_{12}	75% N(GC) + 25% N(Urea)	0.10	0.12	0.10	0.17
T_{13}	Absolute control	0.05	0.08	0.06	0.12
	SE ±	0.003	0.004	0.004	0.004
	C.D.(P=0.05)	0.009	0.013	0.011	0.014

At harvest, the highest P content (0.13%) was found in treatment T_5 (50 % N through vermicompost + 50 % N through Urea), which was significantly higher over the rest of the treatment. The treatments T_3, T_6, T_7 and T_8 were at par with each other and the lowest P content (0.06%) was found in treatment T_{13} (Absolute control).

It was also observed that the P content in chilli plant was maximum at 60 DAT and declined slightly from 60 DAT till harvest. Similar results and trends were found by Kokare (2013).

4.3.2.2 Phosphorous content in green chilli pod.

At harvest stage, the P content in green chilli pod was significantly affected due to various treatments and it ranged from 0.12 to 0.18 per cent. The highest P content in pod (0.18 %) was observed by T_8 receiving 50 per cent N through poultry manure and 50 per cent N through urea, which was significantly higher over rest of other treatments. The treatments T_2, T_4, T_5, T_6, T_9 and T_{12} were found to be at par with each other. The ranges of phosphorus content are in agreement with those reported by Kasture (2001) and Kokare (2013).

4.3.3 Effect on Potassium content

Effect of different sources of organic manures and their combination on potassium content in chilli variety Konkan Kirti at different growth stages of crop is presented in Table.11

4.3.3.1 Potassium content in chilli plant

The data pertaining to potassium content in chilli plant given in Table.11. It was observed that at 30, 60 DAT and at harvest was significantly affected due to various treatments and it is ranged from 3.13 to 5.03 per cent at 30 DAT, 4.12 to 5.12 per cent at 60 DAT and 2.06 to 4.52 per cent at harvest.

At the 30 days after transplanting, maximum k content (5.03%) was found in the Treatment T_8 (50 N through poultry manure + 50 % N through Urea) which was significantly higher over the rest of the treatments except treatment T_4 and T_{11} which was at par with this treatment.

Table 11: Effect of different sources of organic manures and their combination on potassium content in plants at different stages and pod.

Tr. No.	Treatment Details	Total Potassium (%)			
		30 DAT	60 DAT	At harvest	Pod
T_1	25% N(FYM) + 75% N(Urea)	3.34	4.64	3.12	2.35
T_2	50% N(FYM) + 50% N(Urea)	4.01	4.71	2.64	2.44
T_3	75% N(FYM) + 25% N(Urea)	3.80	4.88	2.66	2.36
T_4	25% N(VC) + 75% N(Urea)	4.52	4.82	3.41	2.85
T_5	50% N(VC) + 50% N(Urea)	3.95	4.95	3.94	2.81
T_6	75% N(VC) + 25% N(Urea)	4.18	4.88	4.52	2.43
T_7	25% N(PM) + 75% N(Urea)	3.81	4.66	3.93	2.20
T_8	50% N(PM) + 50% N(Urea)	5.03	5.12	3.53	3.20
T_9	75% N(PM) + 75% N(Urea)	4.03	4.96	3.90	2.55
T_{10}	25% N(GC) + 75% N(Urea)	3.88	4.86	3.43	2.69
T_{11}	50% N(GC) + 50% N(Urea)	4.47	4.97	2.94	2.36
T_{12}	75% N(GC) + 75% N(Urea)	3.15	4.44	2.76	2.44
T_{13}	Absolute control	3.13	4.12	2.06	1.93
	SE ±	0.29	0.17	0.24	0.13
	C.D.(P=0.05)	0.84	0.51	0.71	0.37

At 60 DAT, the highest K content (5.12%) was found in treatment T_8 (50 N through poultry manure + 50 % N through Urea), which was significantly higher over the rest of the treatments except, treatment T_{12} and T_{13} all treatments were at par with this treatments and the lowest K content (4.12%) was found in treatment T_{13} (Absolute control).

At harvest, the highest K content (4.52%) was found in treatment T_6 (75% N through Vermicompost + 25 % N through Urea), which was significantly higher over the rest of the treatments except treatment T_5, T_7 and T_9 were found at par with each other and the lowest K content (2.06%) was found in treatment T_{13} (Absolute control).

It was also observed that the potassium content in chilli plant was maximum at 60 DAT and declined gradually from 60 DAT till harvest. Such phenomenon is probably associated with the K fixation and released characters of soil, mineralization of organic K from organic manures and its availability vis-à-vis N applied. Similar results and trends were found by Vimala *et al* (2007) and Kokare (2013).

4.3.3.2 Potassium content in green chilli pod.

At harvest stage, the K content in green chilli pod was significantly affected due to various treatments and it is ranged from 1.93 to 3.20 per cent. The highest K content in pod (3.20 %) was contributed by T_8 receiving 50 per cent N through poultry manure and 50 per cent N through urea, which was significantly superior over rest of other treatments except, treatment T_4 which was found to be at par with treatment T_8. The ranges of K content were in agreement with those reported by Kasture (2001) and Kokare (2013).

4.3.4 Effect on Iron content

4.3.4.1 Iron content in chilli plant

Table 12: Effect of different sources of organic manures and their combination on Iron content in plants at different stages and pod.

Tr. No.	Treatment Details	Fe (mg kg^{-1})			
		30 DAT	60 DAT	At harvest	Pod
T_1	25% N(FYM) + 75% N(Urea)	37.52	33.10	29.39	13.13
T_2	50% N(FYM) + 50% N(Urea)	39.29	35.31	30.71	15.33
T_3	75% N(FYM) + 25% N(Urea)	41.89	36.15	32.99	17.30
T_4	25% N(VC) + 75% N(Urea)	38.48	31.40	29.74	15.37
T_5	50% N(VC) + 50% N(Urea)	39.20	33.39	30.78	19.20
T_6	75% N(VC) + 25% N(Urea)	43.38	39.27	35.81	18.40
T_7	25% N(PM) + 75% N(Urea)	38.24	35.95	31.42	15.60
T_8	50% N(PM) + 50% N(Urea)	39.08	30.77	29.30	21.03
T_9	75% N(PM) + 25% N(Urea)	42.60	38.47	34.21	17.55
T_{10}	25% N(GC) + 75% N(Urea)	39.77	35.89	31.71	14.88
T_{11}	50% N(GC) + 50% N(Urea)	39.96	34.62	30.63	15.61
T_{12}	75% N(GC) + 25% N(Urea)	36.49	32.82	30.04	14.67
T_{13}	Absolute control	29.87	31.24	31.11	11.43

	SE ±	3.489	3.142	2.251	1.29
	C.D.(P=0.05)	NS	NS	NS	3.75

The variation in the Fe content due to various treatments in chilli plant was found to be non-significant at all three stages i.e. 30, 60 days after transplanting and at harvest. It ranged from 29.87 to 43.38 mg kg^{-1} at 30 DAT, 31.24 to 39.95 mg kg^{-1} at 60 DAT and 29.30 to 35.81 mg kg^{-1} at harvest.

At the 30 DAT, maximum Fe content (43.38 mg kg^{-1}) was found in the Treatment T_6 (75% N through Vermicompost + 25 % N through Urea) and lowest Fe content (29.87 mg kg^{-1}) was found in treatment T_{13} (Absolute control).

At 60 DAT, the highest Fe content (39.95 mg kg^{-1}) was found in treatment T_6 (75 % N through Vermicompost + 25 % N through Urea), and the lowest Fe content (31.24 mg kg^{-1}) was found in treatment T_{13} (Absolute control).

At harvest, the highest Fe content (35.81 mg kg^{-1}) was found in treatment T_6 (75% N through Vermicompost + 25 % N through Urea), and the lowest Fe content (29.30 mg kg^{-1}) was found in treatment T_8 receiving 50 per cent N through poultry manure and 50 per cent N through urea. It was also observed that the Fe content showed decreasing trend after 30 DAT till at harvest.

4.3.4.2 Iron content in green chilli pod.

At harvest stage, the Fe content in green chilli pod was significantly affected due to various treatments and it is ranged from 11.43 to 21.03 mg kg^{-1}. The highest Fe content in pod (21.03 mg kg^{-1}) was observed in T_8 receiving 50 per cent N through poultry manure and 50 per cent N through urea, which was significantly superior over rest of other treatments except, treatments T_3, T_5, T_6 and T_9 which was found to be at par with treatment T_8 and the lowest Fe content (11.43 mg kg^{-1}) was found in treatment T_{13} (Absolute control).

Vermicompost is one of the excellent organic manure which is rich in the nutrient essential to plants. It also comprises several micronutrients like Fe, Mn etc. Similar results were found by Kokare (2013).

4.3.5 Effect on Manganese content

4.3.5.1 Manganese content in chilli plant

The variation in the Mn content due to various treatments in chilli plant was found to be non-significant at 30, 60 days after transplanting and significant at harvest. It ranged from 114.73 to 217.80 mg kg^{-1} at 30 DAT, 99.20 to 171.15 mg kg^{-1} at 60 DAT and 88.3 to 161.49 mg kg^{-1} at harvest.

Table 13: Effect of different sources of organic manures and their combination on Manganese content in plants at different stages and pod.

Tr. No.	Treatment Details	Mn (mg kg^{-1})			
		30 DAT	60 DAT	At harvest	Pod
T_1	25% N(FYM) + 75% N(Urea)	151.39	145.55	128.96	38.43
T_2	50% N(FYM) + 50% N(Urea)	169.33	147.37	115.54	39.08
T_3	75% N(FYM) + 25% N(Urea)	191.42	143.37	126.81	36.58
T_4	25% N(VC) + 75% N(Urea)	158.26	150.14	112.02	41.25
T_5	50% N(VC) + 50% N(Urea)	149.25	141.81	112.30	46.27
T_6	75% N(VC) + 25% N(Urea)	203.21	171.15	117.44	50.71
T_7	25% N(PM) + 75% N(Urea)	161.97	150.83	134.37	41.90
T_8	50% N(PM) + 50% N(Urea)	217.80	159.73	161.49	42.35
T_9	75% N(PM) + 25% N(Urea)	185.18	145.65	116.09	46.78
T_{10}	25% N(GC) + 75% N(Urea)	187.87	147.79	106.66	35.35
T_{11}	50% N(GC) + 50% N(Urea)	188.85	169.25	102.90	38.08
T_{12}	75% N(GC) + 25% N(Urea)	147.04	103.79	118.67	38.90
T_{13}	Absolute control	114.73	99.20	88.33	33.91
	SE ±	21.68	17.62	10.76	4.46
	C.D.(P=0.05)	NS	NS	31.4	NS

At the 30 DAT, maximum Mn content (217.80 mg kg^{-1}) was found in the Treatment T_8 (50 % N through poultry manure + 50 % N through Urea) and lowest Mn content (114.73 mg kg^{-1}) was found in treatment T_{13} (Absolute control).

At 60 DAT, the highest Mn content (171.15 mg kg^{-1}) was found in treatment T_6 (75 % N through Vermicompost + 25 % N through Urea), and the lowest Mn content (99.20 mg kg^{-1}) was found in treatment T_{13} (Absolute control).

At harvest, the highest Mn content (161.49 mg kg^{-1}) was found in treatment T_8 (50 N through poultry manure + 50 % N through Urea), which was found significantly superior over rest of other treatment except, treatment T_7 (25 % N through poultry manure and 75 % N through urea), which was found at par with treatment T_8. The lowest Mn content (88.33 mg kg^{-1}) was found in treatment T_{13} (Absolute control). It was also observed that the Fe content showed decreasing trend from 30 DAT till at harvest.

4.3.5.2 Manganese content in green chilli pod.

At harvest stage, the Mn content in green chilli pod was non-significant, it ranged from 33.91 to 50.11 mg kg^{-1}. The highest Mn content in pod (50.11 mg kg^{-1}) was observed in T_6 receiving 75 per cent N through Vermicompost and 25 per cent N through urea and the lowest Mn content (33.91 mg kg^{-1}) was found in treatment T_{13} (Absolute control).

4.3.6 Effect on Zinc content

4.3.6.1 Zinc content in chilli plant

The variation in the Zn content due to various treatments in chilli plant was found to be non-significant at all three stages i.e. 30, 60 days after transplanting and at harvest. It ranged from 32.27 to 60.83 mg kg^{-1} at 30 DAT, 40.57 to 82.27 mg kg^{-1} at 60 DAT and 27.10 to 61.33 mg kg^{-1} at harvest.

Maximum Zn content was observed in treatment T_8 (60.83 mg kg^{-1}), T_8 (82.27 mg kg^{-1}), T_6 (61.33 mg kg^{-1}) at 30, 60 days after transplanting and at harvest respectively and minimum Zn content was observed in treatment T_{13} (32.27 mg kg^{-1}), T_{13} (40.57 mg kg^{-1}) and T_{13} (27.10 mg kg^{-1}) at 30, 60 DAT and at harvest, respectively.

4.3.6.2 Zinc content in green chilli pod.

At harvest stage, the Zn content in green chilli pod was non-significant. The content due to various treatments was seen to vary from 33.43 to 43.00 mg kg^{-1}. The highest Zn content in pod (43.00 mg kg^{-1}) was observed in T_6 receiving 75 per cent N through Vermicompost and 25 per cent N through urea and the lowest Zn content (33.43 mg kg^{-1}) was found in treatment T_{13} (Absolute control).

Table 14: Effect of different sources of organic manures and their combination on Zn content in plants at different stages and pod.

Tr. No.	Treatment Details	Zn (mg kg^{-1})			
		30 DAT	60 DAT	At harvest	Pod
T_1	25% N(FYM) + 75% N(Urea)	53.60	54.23	47.53	38.23
T_2	50% N(FYM) + 50% N(Urea)	46.63	55.40	53.73	39.33
T_3	75% N(FYM) + 25% N(Urea)	45.60	52.60	58.33	37.30
T_4	25% N(VC) + 75% N(Urea)	40.60	51.33	49.77	40.43
T_5	50% N(VC) + 50% N(Urea)	43.53	56.17	43.47	37.83
T_6	75% N(VC) + 25% N(Urea)	33.37	70.03	61.33	43.00
T_7	25% N(PM) + 75% N(Urea)	32.47	62.33	49.83	41.77
T_8	50% N(PM) + 50% N(Urea)	60.83	82.27	40.27	38.70
T_9	75% N(PM) + 25% N(Urea)	43.03	66.63	49.43	39.27
T_{10}	25% N(GC) + 75% N(Urea)	36.23	53.80	53.63	33.57
T_{11}	50% N(GC) + 50% N(Urea)	38.17	50.27	46.17	38.40
T_{12}	75% N(GC) + 25% N(Urea)	36.97	53.17	47.17	38.83
T_{13}	Absolute control	32.27	40.57	27.10	33.43
	SE ±	7.853	8.563	6.653	3.30
	C.D.(P=0.05)	NS	NS	NS	NS

4.3.7 Effect on Copper content

4.3.7.1 Copper content in chilli plant

The variation in the Cu content due to various treatments in chilli plant was found to be non-significant at all three stages i.e. 30, 60 days after transplanting and at harvest. It ranged from 38.60 to

59.70 mg kg^{-1} at 30 DAT, 75.13 to 87.57 mg kg^{-1} at 60 DAT and 27.83 to 68.10 mg kg^{-1} at harvest.

Maximum Cu content was observed in treatment T_{12} (59.70 mg kg^{-1}), (87.57 mg kg^{-1}) at 30, 60 days after transplanting and at harvest in T_{10} (68.10 mg kg^{-1}) and minimum Cu content was observed in treatment T_2 (38.60 mg kg^{-1}), T_5 (75.13 mg kg^{-1}) and T_5 (27.83 mg kg^{-1}) at 30, 60 DAT and at harvest, respectively.

Table 15: Effect of different sources of organic manures and their combination on Cu content in plants at different stages and pod.

Tr. No.	**Treatment Details**	**Cu (mg kg^{-1})**			
		30 DAT	60 DAT	At harvest	Pod
T_1	25% N(FYM) + 75% N(Urea)	51.30	77.53	33.07	35.93
T_2	50% N(FYM) + 50% N(Urea)	38.60	78.63	61.33	42.87
T_3	75% N(FYM) + 25% N(Urea)	44.10	80.67	51.77	51.30
T_4	25% N(VC) + 75% N(Urea)	54.70	81.60	53.33	56.40
T_5	50% N(VC) + 50% N(Urea)	56.40	75.73	27.83	64.20
T_6	75% N(VC) + 25% N(Urea)	46.70	84.50	58.97	45.47
T_7	25% N(PM) + 75% N(Urea)	51.70	76.47	47.03	33.40
T_8	50% N(PM) + 50% N(Urea)	54.60	75.13	39.30	37.17
T_9	75% N(PM) + 25% N(Urea)	52.00	79.23	53.13	58.93
T_{10}	25% N(GC) + 75% N(Urea)	54.30	78.97	68.10	37.00
T_{11}	50% N(GC) + 50% N(Urea)	57.20	85.30	52.87	34.10
T_{12}	75% N(GC) + 25% N(Urea)	59.70	87.57	39.80	53.90
T_{13}	Absolute control	56.10	86.17	43.07	34.17
	SE ±	4.934	7.474	8.174	9.98
	C.D.(P=0.05)	NS	NS	NS	NS

4.3.7.2 Copper content in green chilli pod.

At harvest stage, the Cu content in green chilli pod was found to be non-significant. The content due to various treatments ranged from

33.40 to 64.20 mg kg^{-1}. The highest Cu content in Pod (64.20 mg kg^{-1}) was contributed by T_5 receiving 50 per cent N through Vermicompost and 50 per cent N through urea, and the lowest Cu content (33.40 mg kg^{-1}) was found in treatment T_7.

4.4 Effect on uptake of nutrient by chilli

The data pertaining to the uptake of nutrients by chilli pod, stover and total nutrient uptake by chilli crop as influenced by different treatments due to application of different sources of organic manures and their combination on chilli are presented in Table 16 to 19.

4.4.1 Nitrogen uptake

The data in respect of the nitrogen uptake by chilli plant due to the effect of application of different sources of organic manures and their combination is presented in Table 16 and depicted in Fig 5.

Table 16: Effect of different sources of organic manures and their combination on uptake of nitrogen

Tr. No.	Treatment Details	Nitrogen (kg ha^{-1})		
		Stover	**Pod**	**Total**
T_1	25% N(FYM) + 75% N(Urea)	17.46	12.08	29.54
T_2	50% N(FYM) + 50% N(Urea)	14.01	11.84	25.85
T_3	75% N(FYM) + 25% N(Urea)	15.01	13.49	28.50
T_4	25% N(VC) + 75% N(Urea)	15.22	13.64	28.86
T_5	50% N(VC) + 50% N(Urea)	14.65	8.82	23.46
T_6	75% N(VC) + 25% N(Urea)	11.91	14.40	26.30
T_7	25% N(PM) + 75% N(Urea)	15.53	14.37	29.89
T_8	50% N(PM) + 50% N(Urea)	17.73	18.35	36.08
T_9	75% N(PM) + 25% N(Urea)	18.38	11.76	30.13
T_{10}	25% N(GC) + 75% N(Urea)	14.78	12.14	26.92
T_{11}	50% N(GC) + 50% N(Urea)	14.69	15.36	30.05
T_{12}	75% N(GC) + 25% N(Urea)	12.46	13.51	25.97
T_{13}	Absolute control	9.13	6.89	16.02
	SE ±	1.57	1.57	2.36
	C.D.(P=0.05)	4.57	4.57	6.90

It is observed from the data that the uptake of nitrogen in the stover ranged from 9.13 to 18.38 kg ha^{-1} due to effect of various treatments and it was found statistically significant. The maximum uptake (18.38 kg ha^{-1}) was recorded by the treatment T_9 receiving 75 % N through poultry manure and 25 % N through urea, which was found to be significantly higher over the treatments T_6, T_{12} and T_{13} but at par with all other treatment. Minimum uptake (9.13 kg ha^{-1}) was recorded at treatment absolute control.

The uptake of nitrogen by the chilli pod increased from 6.89 to 18.35 kg ha^{-1} due to effect of various treatments and it was found to be statistically significant. Among the various treatments the maximum uptake of nitrogen was recorded in treatment T_8 (18.35 kg ha^{-1}) with application of 50 % N through poultry manure and 50 % N through urea, which was significantly higher over rest of other treatments except treatment T_6, T_7, and T_{11} with which it was found to be at par. Minimum uptake (6.89 kg ha^{-1}) was recorded in treatment absolute control.

Total nitrogen uptake was seen to be in the range from 16.02 to 36.08 kg ha^{-1} due to effect of different treatments. The maximum uptake (36.08 kg ha^{-1}) was recorded with treatment T_8 i.e. application of 50 % N through poultry manure and 50 % N through urea, which was significantly higher over other treatments and treatment T_1, T_3, T_4, T_7, T_9 and T_{11} was found to be at par. Ranges of total nitrogen uptake by chilli at harvest quoted here are in agreement with Kasture (2001) and Kokare (2013) in chilli and Kadam *et al.* (2005) in tomato.

Significant increase in total nitrogen uptake by Chilli with application of organic manures in combination with inorganic fertilizer over control may be due to continuous availability of nitrogen as well as increase in the yield by application of different treatments.

4.4.2 Phosphorus uptake

The data in respect of the phosphorus uptake by chilli plant due to the effect of application of different sources of organic manures and their combination is presented in Table 17 and depicted in Fig 6.

It is observed from the data that the uptake of phosphorus in the stover ranged from 0.45 to 1.43 kg ha^{-1} due to effect of various treatments and it was found to be statistically significant. The maximum uptake (1.43 kg ha^{-1}) was recorded by the treatment T_8 receiving 50 % N through poultry manure and 50 % N through urea, which was found to be at par with rest of the treatments except T_{13} (absolute control). Minimum uptake (0.45 kg ha^{-1}) was recorded in treatment T_{13}.

Table 17: Effect of different sources of organic manures and their combination on uptake of phosphorus.

Tr. No.	Treatment Details	Phosphorus (kg ha^{-1})		
		Stover	Pod	Total
T_1	25% N(FYM) + 75% N(Urea)	1.35	1.23	2.59
T_2	50% N(FYM) + 50% N(Urea)	1.12	1.60	2.72
T_3	75% N(FYM) + 25% N(Urea)	1.41	1.35	2.76
T_4	25% N(VC) + 75% N(Urea)	1.38	1.47	2.85
T_5	50% N(VC) + 50% N(Urea)	1.42	1.67	3.09
T_6	75% N(VC) + 25% N(Urea)	1.12	1.71	2.82
T_7	25% N(PM) + 75% N(Urea)	1.39	1.44	2.83
T_8	50% N(PM) + 50% N(Urea)	1.43	1.97	3.40
T_9	75% N(PM) + 25% N(Urea)	1.39	1.50	2.89
T_{10}	25% N(GC) + 75% N(Urea)	1.02	1.40	2.42
T_{11}	50% N(GC) + 50% N(Urea)	1.16	1.22	2.38
T_{12}	75% N(GC) + 25% N(Urea)	0.99	1.86	2.85
T_{13}	Absolute control	0.45	0.71	1.16
	SE ±	0.15	0.13	0.25
	C.D.(P=0.05)	0.44	0.40	0.73

The uptake of phosphorus by the chilli pod ranged from 0.71 to 1.97 kg ha^{-1} due to effect of various treatments and it was found to be statistically significant. Among the various treatments the maximum uptake of phosphorus was recorded in treatment T_8 (1.97 kg ha^{-1}) with application of 50 % N through poultry manure and 50 % N through urea, which was significantly higher over rest of other treatments except treatment T_2, T_5, T_6 and T_{12} which was found to be at par. Minimum uptake (0.71 kg ha^{-1}) was recorded at treatment absolute control.

Total phosphorus uptake was seen to be in the range of 1.16 to 3.40 kg ha^{-1} due to effect of different treatments. The maximum uptake (3.40 kg ha^{-1}) was recorded with treatment T_8 i.e. application of 50 % N through poultry manure and 50 % N through urea, which was significantly higher over other treatments except treatments T_1, T_{10}, T_{11} and T_{13}. Similar results of total phosphorus uptake was found by Kasture (2001) and Kokare (2013) in chilli.

Overall, results indicate that the highest uptake of phosphorus was observed in treatments receiving combined application of organic manure with inorganic fertilizer. Vasanthi and kumaraswamy (2000) noted the positive effect of organic manure on uptake of Phosphorus by the crop, which may attributed to the chelation of micronutrients and Ca and Mg preventing them from fixing P in insoluble compounds.

4.4.3 Potassium uptake

The data in respect of the Potassium uptake by chilli plant due to the effect of application of different sources of organic manures and their combination is presented in Table 18.and depicted in Fig 7.

It can be observed from the data that the uptake of potassium in the stover ranged from 16.99 to 51.11 kg ha^{-1} due to effect of various treatments and it was found statistically significant. The maximum uptake (51.11 kg ha^{-1}) was recorded by the treatment T_9 receiving 75% N through poultry manure and 25% N through urea, which was found to be significantly higher over other treatments, except treatment T_2,

T_3, T_{12} and T_{13}. Minimum uptake (16.99 kg ha^{-1}) was recorded by treatment T_{13} (absolute control).

The uptake of potassium by the chilli pod ranged in between 11.03 to 34.89 kg ha^{-1} due to effect of various treatments and it was found to be statistically significant. Among the various treatments the maximum uptake of potassium was recorded in treatment T_8 (34.89 kg ha^{-1}) with application of 50% N through poultry manure and 50% N through urea, which was significantly superior over rest of all the treatments. The minimum uptake (11.03 kg ha^{-1}) was recorded at treatment T_{13}.

Table 18: Effect of different sources of organic manures and their combination on uptake of potassium.

Tr. No.	Treatment Details	Potassium (kg ha^{-1})		
		Stover	Pod	Total
T_1	25% N(FYM) + 75% N(Urea)	48.46	20.97	69.42
T_2	50% N(FYM) + 50% N(Urea)	28.68	23.84	52.52
T_3	75% N(FYM) + 25% N(Urea)	33.71	22.72	54.95
T_4	25% N(VC) + 75% N(Urea)	43.36	24.85	65.09
T_5	50% N(VC) + 50% N(Urea)	44.55	28.56	70.55
T_6	75% N(VC) + 25% N(Urea)	41.54	25.11	65.62
T_7	25% N(PM) + 75% N(Urea)	47.58	22.97	70.55
T_8	50% N(PM) + 50% N(Urea)	44.06	34.89	69.00
T_9	75% N(PM) + 25% N(Urea)	51.11	23.47	74.58
T_{10}	25% N(GC) + 75% N(Urea)	38.19	25.47	63.66
T_{11}	50% N(GC) + 50% N(Urea)	36.52	22.71	57.96
T_{12}	75% N(GC) + 25% N(Urea)	26.02	26.77	52.79
T_{13}	Absolute control	16.99	11.03	28.02
	SE ±	5.21	2.13	6.46
	C.D.(P=0.05)	15.20	6.23	18.45

Total uptake of potassium was observed to be in the range of 28.02 to 74.58 kg ha^{-1} due to effect of different treatments. The maximum uptake (74.58 kg ha^{-1}) was recorded with treatment T_9 i.e. application of 75% N through poultry manure and 25% N through urea, which was significantly higher over other treatments, except treatments T_2, T_3, T_{12} and T_{13}. Similar results of total phosphorus uptake was found by Kasture (2001) and Kokare (2013) in chilli.

The results indicated that K uptake increased with the age of the crop. Organic manure with fertilizers treated plots showed more potassium uptake with increased addition of K through organic manures. Bhandari *et al.* (1992) noted that K uptake in all fertilizers and manurial treatment increased significantly over control plot. This may be due to more availability of these nutrient from added fertilizers and to the solubilizing action on K of organic acid produced during degradation of organic acids.

4.4.4 Iron uptake

The data in respect of the iron uptake by chilli plant due to the application of different sources of organic manures and their combination on chilli is presented in Table 19.

It is observed from the data that the uptake of Fe in the stover ranged from 255.47 to 474.87 g ha^{-1} due to effect of various treatments, which was found to be non-significant. The maximum uptake (474.87 g ha^{-1}) was recorded at treatment T_9 receiving 75% N through poultry manure and 25% N through urea. Minimum uptake (255.47g ha^{-1}) was recorded at treatment T_{13} (absolute control).

The uptake of Fe by the chilli pod ranged in between 65.32 to 229.77 g ha^{-1} due to effect of various treatments. It significantly increased under different treatments over control. Among the various treatments the maximum (229.77 g ha^{-1}) uptake of Fe was recorded with treatment T_8 receiving 50% N through poultry manure and 50% N through urea, which was significantly superior over the rest of all treatments except T_5 (194.68 g ha^{-1}) and T_6 (189.84 g ha^{-1}), with which was at par. This might be due to the application of poultry manure followed by vermicompost which enhance the Fe uptake by plant. The lowest Fe uptake (65.32 g ha^{-1}) was observed with T_{13} (absolute control).

The total uptake of iron by the chilli plant due to various treatments was seen to be non-significant. The uptake of iron ranged from 320.79 to 637.95 g ha^{-1}. The maximum uptake (637.95 g ha^{-1}) was recorded in the treatment T_9 receiving 75% N through poultry manure and 25% N through urea. Minimum uptake (320.79 g ha^{-1}) was recorded at treatment T_{13} (absolute control). Similar ranges were reported by Kokare (2013). Application of poultry manure records higher uptake than other treatment. This might be due to the complexion properties of poultry manures must have prevented precipitation and fixation of iron and keep it in available form which was reported by Talashilkar (1997).

Table 19: Effect of different sources of organic manures and their combination on uptake of micronutrients

Treatment. No.	**Fe** (g ha^{-1})			**Mn** (g ha^{-1})			**Zn** (g ha^{-1})			**Cu** (g ha^{-1})		
	Stover	**Pod**	**Total**	**Stover**	**Pod**	**Total**	**Stover**	**Pod**	**Total**	**Stover**	**Pod**	**Total**
T_1	431.71	117.30	549.01	1980.82	343.07	2323.89	720.05	312.08	1032.13	524.77	324.12	848.88
T_2	332.18	148.21	480.39	1255.21	384.46	1639.66	594.39	383.37	977.76	678.57	418.35	1096.92
T_3	394.49	169.31	563.79	1472.58	362.74	1835.32	660.15	357.72	1017.87	609.00	499.66	1108.66
T_4	372.02	133.74	505.75	1341.77	360.21	1701.97	612.44	354.94	967.38	654.67	491.43	1146.10
T_5	352.38	194.68	547.06	1271.98	469.49	1741.47	482.27	384.05	866.32	307.16	654.04	961.19
T_6	316.76	189.84	506.59	1090.52	516.22	1606.74	567.76	443.50	1011.27	542.11	465.27	1007.38
T_7	381.24	160.93	542.16	1546.40	444.48	1990.88	593.46	443.57	1037.03	551.24	342.28	893.52
T_8	356.92	229.77	586.69	1991.29	461.07	2434.36	470.49	422.10	892.60	435.33	402.48	837.81
T_9	474.87	163.09	637.95	1510.37	438.35	1948.73	679.09	362.22	1041.31	699.94	559.18	1259.12
T_{10}	347.76	143.12	490.88	1168.13	341.09	1509.22	585.10	323.30	908.40	719.40	334.53	1053.93
T_{11}	369.91	152.82	522.73	1259.24	367.85	1627.09	544.71	369.22	913.93	656.22	336.90	993.12
T_{12}	284.83	161.00	445.83	1118.66	438.03	1556.69	444.11	418.24	862.35	361.85	569.97	931.82
T_{13}	255.47	65.32	320.79	701.59	192.89	894.48	220.35	191.86	412.21	346.53	196.44	542.97
S.E. ±	45.50	18.81	53.90	173.44	65.03	189.43	93.76	46.52	107.05	105.34	99.61	151.84
C.D (P=0.05)	NS	54.92	NS	506.25	NS	552.93	NS	NS	312.46	NS	NS	NS

4.4.5 Manganese uptake

From the perusal of data presented in Table 19 on the Mn uptake by chilli plants as a result of application of different sources of organic manures and their combination. It is observed that the uptake is significant in stover and total, but non-significant in pod

Mn uptake by stover was significant. It ranged between 701.59 to 1991.29 g ha^{-1}. The treatment T_8 receiving 50% N through poultry manure and 50% N through urea recorded significantly highest value (1991.29 g ha^{-1}) over rest of the treatments. The treatment T_1 (1980.82 g ha^{-1}), T7 (1546.40 g ha^{-1}) and T_9 (1510.37 g ha^{-1}) were found at par with T_8. Minimum Mn uptake (701.59 g ha^{-1}) was observed in treatment T_{13} control.

Mn uptake by chilli pod ranged from 192.89 to 516.22 g ha^{-1}. The maximum Mn uptake was recorded by treatment T_6 (516.22 g ha^{-1}). Minimum Mn uptake (192.89 g ha^{-1}) was observed in treatment T_{13} control.

Total Mn uptake by chilli plant was seen to be in the range of 894.48 to 2434.36 g ha^{-1}.The treatment T_8 receiving 50% N through poultry manure and 50% N through urea recorded significantly highest value (2434.36 g ha^{-1}) over rest of the treatments. The treatments T_1 (2323.89 g ha^{-1}), T_7 (1990.80 g ha^{-1}) and T_9 (1948.73 g ha^{-1}), were found at par with T_8. Minimum Mn uptake (894.48 g ha^{-1}) was observed in treatment T_{13} control. Higher uptake of Mn was due to the ample of availability of Mn in soil due to the low pH acidic soils.

4.4.6 Zinc uptake

The data in respect of the Zinc uptake by chilli plant due to the application of different sources of organic manures and their combination on chilli is presented in Table 19.

It can be seen from the data that the uptake of Zn in the stover ranged from 220.35 to 720.05 g ha^{-1} due to effect of various treatments. But it was found to be non-significant. The maximum uptake (720.05 g ha-

[1]) recorded at treatment T_1 receiving 25% N through FYM and 75% N through urea. Minimum uptake (220.35 g ha^{-1}) was recorded at treatment T_{13} (absolute control).

The uptake of Zn by the chilli pod ranged from 191.86 to 443.53 g ha^{-1}due to effect of various treatments. It was found to be non-significant. Among the various treatments the maximum (443.53 g ha^{-1}) uptake of Zn was recorded with treatment T_7 receiving 25% N through poultry manure and 75% N through urea. Minimum uptake (191.86 g ha^{-1}) was recorded at treatment T_{13} (absolute control). It might be due to the application of poultry manure followed by vermicompost enhance the Zn uptake by plant.

The total uptake of Zinc by the chilli plant due to various treatments ranged from 412.21 to 1041.31 g ha^{-1}. The maximum uptake (1041.31 g ha^{-1}) was recorded in the treatment T_9 receiving 75% N through poultry manure and 25% N through urea, which was found statistically at par with all the treatments except treatment T_{13}. Minimum uptake (1041.31 g ha^{-1}) was recorded at treatment T_{13} (absolute control).

4.4.7 Copper uptake

The data in respect of the Copper uptake by chilli plant due to the application of different sources of organic manures and their combination on chilli on copper uptake in plants is presented in Table 19.

It is observed from the data that the uptake of Cu in the stover ranged from 346.53 to 719.40 g ha^{-1} due to effect of various treatments. But it was found to be non-significant. The maximum uptake (719.40 g ha^{-1}) was recorded at treatment T_{10} receiving 25% N through groundnut cake and 75% N through urea. Minimum uptake (220.35 g ha^{-1}) was recorded at treatment T_{13} (absolute control).

The uptake of Cu by the chilli pod ranged in between from 196.44 to 654.04 g ha^{-1}due to effect of various treatments. It was found to be non-significant. Among the various treatments the maximum (654.04 g ha^{-1}) uptake of Cu was recorded with treatment T_5 receiving 50% N through

Vermicompost and 50% N through urea and the minimum uptake (196.44 g ha^{-1}) was recorded at treatment T_{13} (absolute control).

The total uptake of copper by the chilli plant due to various treatments ranged from 542.97 to 1259.12 g ha^{-1}. The maximum uptake (1259.12 g ha^{-1}) was recorded in the treatment T_9 receiving 75% N through poultry manure and 25% N through urea. Minimum uptake (1259.12 g ha^{-1}) was recorded at treatment T_{13} (absolute control).

4.5 Effect on quality of chilli.

The data pertaining to the quality of chilli as influenced by different treatments i.e. application of different sources of organic manures and their combination on chilli is presented in Table 20

4.5.1 Effect on ascorbic acid content

The data in respect of ascorbic acid content in chilli pod as affected due to various treatments is presented in Table 20 indicated that the differences were significant and ranged between 30.71 mg $100g^{-1}$ to 66.40 mg100 g^{-1}. The maximum ascorbic acid content (66.40 mg 100 g^{-1}) and significantly superior value than rest of all treatment was reported by T_{10} receiving 25% N through groundnut cake and 75% N through urea but at par with T_8. T_{13} control reported minimum value 30.17 mg 100 g^{-1}. Kasture (2001) also reported similar range of ascorbic acid in chilli pod of variety Konkan Kirti.

The variation in ascorbic acid content might be ascribed due to better availability and uptake of required nutrient and also favorable condition resulted by the poultry manure which helps the synthesis of chlorophyll and increased ascorbic acid content. This a quite evident from the positivity and significant correlation between K content of capsicum and ascorbic acid content reported by Kaminwar and Rajgopal (1993). Increased in ascorbic acid content due to application of organic manure was also reported by Petkov (1964).

Table 20: Effect of different sources of organic manures and their combination on quality of chilli.

Tr. No.	Treatment Details	Ascorbic acid (mg 100 g^{-1})	Capsaicin (%)
T_1	25% N(FYM) + 75% N(Urea)	56.99	0.18
T_2	50% N(FYM) + 50% N(Urea)	51.74	0.18
T_3	75% N(FYM) + 25% N(Urea)	56.16	0.13
T_4	25% N(VC) + 75% N(Urea)	48.69	0.16
T_5	50% N(VC) + 50% N(Urea)	29.05	0.16
T_6	75% N(VC) + 25% N(Urea)	53.95	0.16
T_7	25% N(PM) + 75% N(Urea)	36.52	0.19
T_8	50% N(PM) + 50% N(Urea)	61.14	0.31
T_9	75% N(PM) + 25% N(Urea)	30.71	0.24
T_{10}	25% N(GC) + 75% N(Urea)	66.40	0.14
T_{11}	50% N(GC) + 50% N(Urea)	48.69	0.16
T_{12}	75% N(GC) + 25% N(Urea)	56.16	0.26
T_{13}	Absolute control	30.71	0.10
	SE ±	1.56	0.03
	C.D.(P=0.05)	4.57	0.09

4.5.2 Effect on capsaicin content in chilli pod

The capsaicin content in chilli pod at harvest was in range of 0.10% to 0.31 %. The highest capsaicin content (0.31%) was recorded in treatment T_8 receiving 50% N through poultry manure and 50% N through urea, which was found significantly superior over other treatment except treatment T_9 (75 % N through poultry manure and 25 % N through urea) and T_{12} (50 % N through groundnut cake and 25 % N through urea)

The variation in ascorbic acid and capsaicin content might be ascribed due to better availability and uptake of required nutrients and due to favorable conditions resulted due to the organic manures which helps the synthesis of chlorophyll.

4.6 Effect on chemical properties of soil

4.6.1 Effect on soil pH:

Table 21: Effect of different sources of organic manures and their combination on soil pH

Tr. No.	Treatment Details	pH of soil		
		30 DAT	60 DAT	At harvest
T_1	25% N(FYM) + 75% N(Urea)	5.39	5.46	5.33
T_2	50% N(FYM) + 50% N(Urea)	5.24	5.61	5.15
T_3	75% N(FYM) + 25% N(Urea)	5.32	5.62	5.29
T_4	25% N(VC) + 75% N(Urea)	5.24	5.44	5.18
T_5	50% N(VC) + 50% N(Urea)	5.12	5.52	5.37
T_6	75% N(VC) + 25% N(Urea)	5.26	5.68	5.20
T_7	25% N(PM) + 75% N(Urea)	5.23	5.49	5.32
T_8	50% N(PM) + 50% N(Urea)	5.23	5.75	5.33
T_9	75% N(PM) + 25% N(Urea)	5.22	6.22	5.32
T_{10}	25% N(GC) + 75% N(Urea)	5.17	5.60	5.23
T_{11}	50% N(GC) + 50% N(Urea)	5.19	5.53	5.08
T_{12}	75% N(GC) + 25% N(Urea)	5.13	5.51	5.23
T_{13}	Absolute control	5.26	5.75	5.44
	SE ±	0.07	0.14	0.13
	C.D.(P=0.05)	NS	0.40	NS

The data pertaining to pH of soil is given in table. 21. It was observed that at 30 DAT there were no significant differences due to various treatments. The highest pH (5.39) was recorded in treatment T_1 (25% N through FYM + 75% N through Urea) and the lowest pH (5.12) was recorded in treatment T_5 (50% N through Vermicompost + 50% N Urea).

At 60 DAT, the pH was significantly affected due to different treatments, the highest pH (6.22) was recorded in treatment T_9 receiving 75% N through poultry manures and 25% N through urea and this treatment was at par with remaining all treatments except treatment T_8. It might be due to the Ca present in the poultry manure as well as other complex materials including high amount of organic matter which helps to increase the pH of soil.

At harvest, the pH of soil was not significantly influenced due to various treatments, and highest pH (5.44) was recorded in treatment T_{13} (Control).

It is observed that the pH of soil was increasing up to 60 DAT stage, it might be due to mining of the nutrients responsible for increasing pH of soil, later at harvest it declined slightly, it might be due to the acidifying effect of urea and organic acid produced during the course of decomposition of organic amendments.

4.6.2 Effect on soil EC:

The data pertaining to EC of soil is given in table.22. It can be observed that at 30, 60 DAT and at harvest there are no significant variations due to the treatments. The values were ranged between 0.13 to 0.18 dSm^{-1}, 0.12 to 0.23 dSm^{-1} and 0.11 to 0.17 dSm^{-1}at 30, 60 DAT and at harvest, respectively.

Table 22: Effect of different sources of organic manures and their combination on EC of soil

Tr. No.	Treatment Details	E C of soil (dSm^{-1})		
		30 DAT	60 DAT	At harvest
T_1	25% N(FYM) + 75% N(Urea)	0.14	0.14	0.12
T_2	50% N(FYM) + 50% N(Urea)	0.15	0.12	0.15
T_3	75% N(FYM) + 25% N(Urea)	0.15	0.12	0.14
T_4	25% N(VC) + 75% N(Urea)	0.13	0.18	0.11
T_5	50% N(VC) + 50% N(Urea)	0.13	0.15	0.14
T_6	75% N(VC) + 25% N(Urea)	0.13	0.16	0.15
T_7	25% N(PM) + 75% N(Urea)	0.14	0.19	0.14
T_8	50% N(PM) + 50% N(Urea)	0.15	0.18	0.15
T_9	75% N(PM) + 25% N(Urea)	0.18	0.23	0.17
T_{10}	25% N(GC) + 75% N(Urea)	0.14	0.19	0.11
T_{11}	50% N(GC) + 50% N(Urea)	0.18	0.20	0.15
T_{12}	75% N(GC) + 25% N(Urea)	0.18	0.16	0.11
T_{13}	Absolute control	0.16	0.15	0.12
	SE ±	0.01	0.03	0.01
	C.D.(P=0.05)	NS	NS	NS

At 30 DAT (0.18 dSm^{-1}), 60 (0.23 dSm^{-1}) and at harvest (0.17 dSm^{-1}) were the highest values of electrical conductivity recorded in treatment T_9 receiving 75 per cent N through poultry manure and 25 per cent N through urea.

At 30, 60 DAT and at harvest, values of EC of soil ranged in between 0.11 to 0.23 dSm^{-1} indicating that these soils are containing least soluble salts. The lateritic soils devoid of soluble salts; as reported by number of workers (Anonymous 1990 and Shende 2010).

4.6.3 Effect on soil Organic carbon:

Table 23: Effect of different sources of organic manures and their combination on Organic carbon of soil.

Tr. No.	Treatment Details	Organic Carbon g kg^{-1}		
		30 DAT	60 DAT	At harvest
T_1	25% N(FYM) + 75% N(Urea)	16.77	14.69	14.82
T_2	50% N(FYM) + 50% N(Urea)	14.43	13.65	14.56
T_3	75% N(FYM) + 25% N(Urea)	15.08	17.03	15.60
T_4	25% N(VC) + 75% N(Urea)	9.75	17.16	15.34
T_5	50% N(VC) + 50% N(Urea)	10.53	23.66	16.90
T_6	75% N(VC) + 25% N(Urea)	9.10	16.51	15.60
T_7	25% N(PM) + 75% N(Urea)	11.16	16.25	14.95
T_8	50% N(PM) + 50% N(Urea)	16.64	15.60	15.60
T_9	75% N(PM) + 25% N(Urea)	12.48	17.94	17.68
T_{10}	25% N(GC) + 75% N(Urea)	12.61	14.82	1469
T_{11}	50% N(GC) + 50% N(Urea)	12.35	15.21	15.47
T_{12}	75% N(GC) + 25% N(Urea)	10.14	14.30	15.21
T_{13}	Absolute control	12.02	12.35	14.30
	SE ±	1.64	2.08	0.82
	C.D.(P=0.05)	4.80	NS	NS

The data pertaining to OC of soil is given in Table 23. It is observed that at 30 DAT exhibits significant differences. Highest OC of soil (16.77g kg^{-1}) was recorded in treatment T_1 receiving 25 per cent N through FYM and 75 per cent N through urea and this treatment was at par with T_2, T_3 T_8, T_9, T_{10}, T_{11} and T_{13}.This can be attributed to the addition of organic manures, which increases organic carbon content of soil.

At 60 DAT and at harvest, the OC of soil was not significantly affected due to the different treatment. Highest OC in soil (23.66 g kg^{-1}) was recorded in treatment T5 receiving 50 per cent N through vermicompost and 50 per cent N through urea and T_9 receiving 75 per cent N through poultry manure and 25 per cent N through urea at 60 DAT and at harvest stage of crop respectively. Gupta *et al.* (1988), observed that organic carbon content of soil increased up to 52 days at all levels of FYM application.

Badole and More (2000), observed that the organic carbon content was relatively higher with treatment receiving organic nutrient sources whereas lower OC content was found with treatment receiving in organic sources. This might be due to the non-addition of organic matter with inorganic sources.

4.6.4 Available nitrogen

The perusal of a data on available nitrogen content in soil at 30, 60 DAT and at harvest presented in Table 24 and fig.10. The data indicates significant differences due to the effect of different treatments and revealed that all treatments showed significant increase in available nitrogen status of soil over absolute control at all stages of crop growth.

At 30 DAT, the highest available nitrogen (205 kg ha^{-1}) was recorded in treatment T_{12} receiving 75 per cent N through groundnut cake and 25 per cent N through urea, which was significantly superior over all treatments except treatment T_8 receiving 50 per cent N through poultry manure and 50 per cent N through urea. The availability of nitrogen in treatment T_{12} might be due to the higher content of nitrogen in groundnut cake. Similar results were also observed by Maheshwari *et al.* (2015).

At 60 DAT, available nitrogen status of soil ranged from 147.39 kg ha^{-1} to 223.70 kg ha^{-1}. The highest available nitrogen (223.70 kg ha^{-1}) was recorded in treatment T_8 receiving 50 per cent N through poultry manure and 50 per cent N through urea, which was found significantly superior over other treatments except treatment T_6 (210.11 kg ha^{-1}), T_9 (211.16 kg ha^{-1}) and T_{10} (204.89 kg ha^{-1}).

Table 24: Effect of different sources of organic manures and their combination on available nitrogen.

Tr.	Treatment Details	Available nitrogen (kg ha^{-1})

No.		30 DAT	60 DAT	At harvest
T_1	25% N(FYM) + 75% N(Urea)	166.21	188.16	156.80
T_2	50% N(FYM) + 50% N(Urea)	147.39	170.39	142.17
T_3	75% N(FYM) + 25% N(Urea)	173.53	183.98	147.39
T_4	25% N(VC) + 75% N(Urea)	159.94	194.43	132.76
T_5	50% N(VC) + 50% N(Urea)	151.57	187.11	153.66
T_6	75% N(VC) + 25% N(Urea)	164.12	210.11	154.71
T_7	25% N(PM) + 75% N(Urea)	177.71	198.61	149.48
T_8	50% N(PM) + 50% N(Urea)	186.07	223.70	172.48
T_9	75% N(PM) + 25% N(Urea)	171.43	211.16	140.07
T_{10}	25% N(GC) + 75% N(Urea)	178.75	204.89	136.94
T_{11}	50% N(GC) + 50% N(Urea)	174.57	195.48	132.76
T_{12}	75% N(GC) + 25% N(Urea)	205.93	190.25	143.21
T_{13}	Absolute control	139.03	147.39	103.49
	SE ±	9.16	7.19	7.01
	C.D.(P=0.05)	26.73	20.98	20.48

At harvest, the nitrogen availability ranged between 103.49 kg ha^{-1} to 172.48 kg ha^{-1}. The highest available nitrogen (172.48 kg ha^{-1}) was recorded in treatment T_8 receiving 50 per cent through poultry manure and 50 per cent N through urea, which was significantly superior over all treatments except treatment T_1 (156.80 kg ha^{-1}) and T_6 (154.71 kg ha^{-1}). At 60 DAT and at harvest, it was observed that the highest availability of N was recorded in treatment T_8 receiving 50 per cent through poultry manure and 50 per cent N through urea. Ullah *et al.* (2008) reported that availability of nitrogen in soil was increased by poultry manure application.

It is also observed from data that the content of available nitrogen is increased up to 60 DAT and later on decreased at harvest of chilli crop. It may be due to the mineralization and utilization of N by the crop (Surender and Sitaramayya, 1997). Rokima and Prasad (1989) observed the improvement in soil available nitrogen due to application of organic manure, which might be due to greater capacity of organic acids to adsorb NO_3^- and NH_4^+. The pronounced effect of organic manures on N availability might be due to solubilization of different organic nitrogenous compounds into available form as reported by Puranik *et al.* (1978). Prasad *et al.* (1986) reported that integrated use of NPK + Green manure or FYM improved the available nitrogen status to a maximum extent which might be due to mineralization rate of soil nitrogen caused due to greater multiplication of soil microbes resulting into higher nitrogen availability.

4.6.5 Available phosphorus

The perusal of a data on available phosphorus content in soil at 30, 60 DAT and at harvest presented in Table 25 and depicted in fig.11 indicated significant differences due to the effect of different treatments. It was revealed that all treatments showed significant increase in available phosphorus status of soil over absolute control at all stages of crop growth.

Table 25: Effect of different sources of organic manures and their combination on available phosphorus of soil.

Tr. No.	Treatment Details	Available phosphorus (kg ha^{-1})		
		30 DAT	60 DAT	At harvest
T_1	25% N(FYM) + 75% N(Urea)	14.61	8.45	8.53
T_2	50% N(FYM) + 50% N(Urea)	10.58	8.85	10.90
T_3	75% N(FYM) + 25% N(Urea)	21.40	6.16	9.00
T_4	25% N(VC) + 75% N(Urea)	19.03	8.61	9.64
T_5	50% N(VC) + 50% N(Urea)	23.14	13.27	20.46
T_6	75% N(VC) + 25% N(Urea)	18.64	7.98	11.53
T_7	25% N(PM) + 75% N(Urea)	12.87	9.08	18.96
T_8	50% N(PM) + 50% N(Urea)	18.24	12.87	20.30
T_9	75% N(PM) + 25% N(Urea)	19.75	11.69	13.27
T_{10}	25% N(GC) + 75% N(Urea)	22.11	10.19	16.90
T_{11}	50% N(GC) + 50% N(Urea)	22.90	8.61	16.51
T_{12}	75% N(GC) + 25% N(Urea)	19.59	8.13	12.56
T_{13}	Absolute control	6.08	2.37	3.32
	SE ±	1.62	1.23	1.53
	C.D.(P=0.05)	4.72	3.60	4.47

At 30 DAT, available phosphorus content in soil ranged from 6.08 kg ha^{-1} to 23.14 kg ha^{-1}. The highest available phosphorus (23.14 kg ha^{-1}) was recorded in treatment T_5 receiving 50 per cent N through vermicompost and 50 per cent N through urea, which was significantly highest but at par with T_3, T_4, T_6, T_9, T_{10}, T_{11} and T_{12}.

At 60 DAT, available phosphorus status of soil ranged from 2.37 kg ha^{-1} to 13.27 kg ha^{-1}. The highest available phosphorus (13.27 kg ha^{-1})

was recorded in treatment T_5 receiving 50 per cent N through vermicompost and 50 per cent N through urea, which was found significantly higher over other treatments and at par with treatment T_8 (12.87 kg ha^{-1}), T_9 (11.69 kg ha^{-1}) and T_{10} (10.19 kg ha^{-1}).

At harvest, the phosphorus availability ranged between 3.32 kg ha^{-1} and 20.46 kg ha^{-1}. The highest available phosphorus (20.46 kg ha^{-1}) was recorded in treatment T_5 receiving 50 per cent through vermicompost and 50 per cent N through urea, which was significantly higher over other treatments except treatment T_7 (18.96 kg ha^{-1}), T_8 (20.30 kg ha^{-1}), T_{10} (16.90 kg ha^{-1}) and T_{11} (16.51kg ha^{-1}). It also observed from data that the content of available phosphorus decreased at 60 DAT and later on increased at harvest of chilli crop. The decrease in available phosphorus as compared to initial level was also reported by Bagal (2009) in lateritic soils of Konkan region.

At 30, 60 DAT and at harvest, it was observed that the highest availability of phosphorus was recorded in treatment T_5 receiving 50 per cent through vermicompost and 50 per cent N through urea. It might be due to the rapid mineralization of organic phosphorus content in vermicompost and partly due to solublization of native insoluble inorganic phosphorus by organic acid produced as result of decomposition. Jayanthi *et al.* (2014), reported that the availability of phosphorus was significantly increased in soil treated with vermifertilizers and vermifertilizer plus NPK. This observation was supported by Maheswari *et al.* (2015), who found that available phosphorus was more in plots that were solarized with vermicompost after the harvest of chilli crop. Prasad and Singhania (1989) reported that the phosphorus enriched manures maintained a higher level of phosphorus in soil solution for longer period than the fertilizers alone.

Similar results had been reported by Jayanthi *et al.* (2014), Maheswari *et al.* (2015) and Kokare (2013).

4.6.6 Available potassium

Table 26: Effect of different sources of organic manures and their combination on available potassium of soil.

Tr. No.	Treatment Details	Available potassium (kg ha^{-1})		
		30 DAT	60 DAT	At harvest
T_1	25% N(FYM) + 75% N(Urea)	335.10	571.20	344.51
T_2	50% N(FYM) + 50% N(Urea)	336.00	657.56	387.52
T_3	75% N(FYM) + 25% N(Urea)	370.94	622.12	507.58
T_4	25% N(VC) + 75% N(Urea)	383.49	670.16	470.40
T_5	50% N(VC) + 50% N(Urea)	365.57	673.89	458.75
T_6	75% N(VC) + 25% N(Urea)	350.34	683.05	418.88
T_7	25% N(PM) + 75% N(Urea)	323.90	620.13	506.24
T_8	50% N(PM) + 50% N(Urea)	496.83	712.97	580.61
T_9	75% N(PM) + 25% N(Urea)	480.26	487.32	587.78
T_{10}	25% N(GC) + 75% N(Urea)	442.62	613.41	481.15
T_{11}	50% N(GC) + 50% N(Urea)	510.72	718.19	605.25
T_{12}	75% N(GC) + 25% N(Urea)	393.79	599.47	586.88
T_{13}	Absolute control	262.98	351.68	303.74
	SE ±	43.61	45.17	47.59
	C.D.(P=0.05)	127.29	131.83	138.92

The perusal of a data on available potassium content in soil at 30, 60 DAT and at harvest presented in Table. 26 and depicted in fig.12 indicated significant differences due to the effect of different treatments and revealed that all treatment showed significant increase in available potassium status of soil over absolute control at all stages of crop growth.

At 30 DAT, the highest available potassium (510.72 kg ha^{-1}) was recorded in treatment T_{11} receiving 50 per cent N through groundnut cake and 50 per cent N through urea, which was significantly highest over other treatments except T_4, T_8, T_9, T_{10} and T_{12}. The lowest available K_2O content in soil was recorded in treatment T_{13} (absolute control).

At 60 DAT, available potassium status of soil ranged from 351.58 kg ha^{-1} to 718.19 kg ha^{-1}. The highest available nitrogen (718.19 kg ha^{-1}) was recorded in treatment T_{11} receiving 50 per cent N through groundnut cake and 50 per cent N through urea, which was found significantly highest over other treatments and was at par with all the treatments except T_1, T_9 and T_{13}.

At harvest, the potassium availability ranged between 303.74 kg ha^{-1} to 605.25 kg ha^{-1}. The highest available potassium (605.25 kg ha^{-1}) was recorded in treatment T_{11} receiving 50 per cent N through groundnut cake and 50 per cent N through urea, which was significantly higher over all treatments but was at par with all the treatments except T_1, T_2, T_5, T_6 and T_{13}.

At 30 DAT, 60 DAT and at harvest, it is observed that the highest availability of K was recorded in treatment T_{11} receiving 50 per cent N through groundnut cake and 50 per cent N through urea and lowest availability of K was recorded in treatment T_{13} (absolute control). It can also be observed from data that the content of available potassium increased at 60 DAT and later on decreased at harvest of chili crop. It might be due to utilization of potassium by chilli crop. Vasanthi and Kumaraswamy (2000) reported that available k content was higher in the treatment that had received manures plus fertilizer. The manures supply K and solubilizes it from K bearing minerals by the organic acids released from the manures.

4.6.7 DTPA Extractable iron

The effect of different sources of organic manures and their combination on DTPA extractable iron was presented in Table 27 and depicted in fig.13. It can be revealed that no significant changes in available Fe content of soil was found at all the stages due to effect of different treatments. The Fe content in soil ranged from 27.80 to 45.30 mg kg^{-1}, 26.73 to 42.49 mg kg^{-1} and 23.67 to 39.47 mg kg^{-1} at 30, 60 days after transplanting and at harvest, respectively. From the results obtained during present investigation, it was estimated that the Fe deficiency is not yet wide spread in the low land lateritic soils of Konkan. Similar ranges were recorded by Patil *et al.* (2012).

Table 27: Effect of different sources of organic manures and their combination on DTPA Extractable Iron.

Tr. No.	Treatment Details	DTPA Extractable Fe (mg kg^{-1})		
		30 DAT	60 DAT	At harvest

T_1	25% N(FYM) + 75% N(Urea)	34.31	34.43	31.23
T_2	50% N(FYM) + 50% N(Urea)	36.44	35.37	32.31
T_3	75% N(FYM) + 25% N(Urea)	34.77	34.17	31.11
T_4	25% N(VC) + 75% N(Urea)	31.81	30.75	26.79
T_5	50% N(VC) + 50% N(Urea)	45.33	42.49	39.47
T_6	75% N(VC) + 25% N(Urea)	37.21	28.20	25.13
T_7	25% N(PM) + 75% N(Urea)	32.48	31.41	28.35
T_8	50% N(PM) + 50% N(Urea)	43.12	42.05	38.99
T_9	75% N(PM) + 25% N(Urea)	41.89	40.83	38.91
T_{10}	25% N(GC) + 75% N(Urea)	30.83	30.20	27.77
T_{11}	50% N(GC) + 50% N(Urea)	39.25	38.05	34.99
T_{12}	75% N(GC) + 25% N(Urea)	41.72	40.65	37.59
T_{13}	Absolute control	27.80	26.73	23.67
	SE ±	4.389	4.875	4.718
	C.D.(P=0.05)	NS	NS	NS

It is seen that the highest availability of Fe i.e. 45.30 mg kg^{-1} at 30 DAT, 42.49 mg kg^{-1} at 60 DAT and 39.47 mg kg^{-1} at harvest in soil was recorded in treatment T_5 receiving 50 per cent N through vermicompost and 50 per cent N through urea and lowest availability of iron in soil was recorded in treatment T_{13} (absolute control) and results were found to be non-significant. It is also observed from data that the content of available iron decreased at 60 DAT and later on again at harvest of chili crop. It might be due to utilization of native iron by chilli crop.

Availability of DTPA extractable Fe was higher due to organic carbon content of soils, use of organic manures, decomposition of organic residues left in the field and climatic conditions of the region. Similar results were also obtained by Patil *et al.* (2012) and Kokare (2013)

4.6.8 DTPA Extractable Manganese

The data pertaining to the available Mn content in soil as influenced by different treatments at 30, 60 DAT and at harvest is presented in Table 28 and depicted in fig.14.

There are no significant changes in available Mn content of soil at 30, 60 DAT and at harvest due to effect of different treatments.

Table 28: Effect of different sources of organic manures and their combination on DTPA Extractable Manganese.

Tr. No.	Treatment Details	DTPA Extractable Mn (mg kg^{-1})		
		30 DAT	60 DAT	At harvest
T_1	25% N(FYM) + 75% N(Urea)	106.67	108.38	103.87
T_2	50% N(FYM) + 50% N(Urea)	101.08	100.90	100.53
T_3	75% N(FYM) + 25% N(Urea)	109.93	119.60	112.00
T_4	25% N(VC) + 75% N(Urea)	108.67	113.47	105.87
T_5	50% N(VC) + 50% N(Urea)	118.13	122.93	115.33
T_6	75% N(VC) + 25% N(Urea)	116.13	120.93	113.33
T_7	25% N(PM) + 75% N(Urea)	111.20	114.90	108.40
T_8	50% N(PM) + 50% N(Urea)	119.07	123.87	116.27
T_9	75% N(PM) + 25% N(Urea)	117.60	122.40	114.80
T_{10}	25% N(GC) + 75% N(Urea)	103.82	113.91	109.20
T_{11}	50% N(GC) + 50% N(Urea)	100.51	112.40	104.80
T_{12}	75% N(GC) + 25% N(Urea)	115.73	120.53	112.93
T_{13}	Absolute control	90.73	94.70	99.73
	SE ±	10.18	8.971	8.699
	C.D.(P=0.05)	NS	NS	NS

At 30 DAT, available Mn status of soil is ranged from 90.73 to 119.07 mg kg^{-1}. Highest value of available Mn (119.07 mg kg^{-1}) was found in treatment T_8 receiving 50 per cent N through poultry manure and 50 per cent N through urea. Lowest value of available Mn (90.73 mg kg^{-1}) was recorded in treatment T_{13} (Absolute control).

At 60 DAT, available Mn status of soil ranged from 94.70 to 123.87 mg kg^{-1}. the highest available Mn (123.87mg kg^{-1}) was found in treatment T_8 receiving 50 per cent N through poultry manure and 50 per cent N through urea and lowest value of available Mn (94.70 mg kg^{-1}) was recorded in treatment T_{13} (Absolute control).

At harvest stage of the crop available Mn ranges between 99.73 to 116.27 mg kg^{-1}.There is slightly decrease in Mn content as compared to previous stage. Maximum Mn (116.27 mg kg^{-1}) was recorded by treatment T_8 receiving 50 per cent N through poultry manure and 50 per cent N through urea, followed by T_5 (115.33 mg kg^{-1}) receiving 50 per cent N through vermicompost and 50 per cent N through urea and lowest value of available Mn (99.73 mg kg^{-1}) was recorded in treatment T_{13} (Absolute control). Similar trends and values were also reported by Talashilkar (1997) and Kokare (2013).

4.6.9 DTPA Extractable Zinc

The available Zn content of soil at 30, 60 DAT and at harvest is presented in Table 29 and depicted in fig.15. It can be observed from the data that the available Zn content at 30, 60 DAT and at harvest ranged from 1.45 to 2.03 mg kg^{-1}, 1.35 to 1.61 mg kg^{-1}, and 1.30 to 1.53 mg kg^{-1} respectively, which was found to be statistically non-significant. Similar ranges in lateritic soil of Konkan was recorded by Bagal (2009).

At 30 DAT available Zn status of soil is ranged from 1.45 mg kg^{-1} to 2.03 mg kg^{-1}. The highest value (2.03 mg kg^{-1}) of available Zn was found in treatment T_6 receiving 75 per cent N through vermicompost and 25 per cent N through urea and lowest value (1.45 mg kg^{-1}) of available Zn was found in treatment T_{13} (Absolute control).

At 60 DAT, the highest available Zn (1.61 mg kg^{-1}) was found in treatment T_6 receiving 75 per cent N through vermicompost and 25 per cent N through urea and lowest value of available Zn (1.35 mg kg^{-1}) was recorded in treatment T_{13} (Absolute control).

Table 29: Effect of different sources of organic manures and their combination on DTPA Extractable Zinc.

Tr. No.	Treatment Details	DTPA Extractable Zn (mg kg^{-1})		
		30 DAT	60 DAT	At harvest
T_1	25% N(FYM) + 75% N(Urea)	1.63	1.49	1.40
T_2	50% N(FYM) + 50% N(Urea)	1.79	1.57	1.51
T_3	75% N(FYM) + 25% N(Urea)	1.53	1.52	1.44
T_4	25% N(VC) + 75% N(Urea)	1.61	1.41	1.34
T_5	50% N(VC) + 50% N(Urea)	1.69	1.51	1.46
T_6	75% N(VC) + 25% N(Urea)	2.03	1.61	1.53
T_7	25% N(PM) + 75% N(Urea)	1.65	1.54	1.45

T_8	50% N(PM) + 50% N(Urea)	1.59	1.51	1.45
T_9	75% N(PM) + 25% N(Urea)	1.58	1.46	1.38
T_{10}	25% N(GC) + 75% N(Urea)	1.53	1.49	1.43
T_{11}	50% N(GC) + 50% N(Urea)	1.55	1.41	1.33
T_{12}	75% N(GC) + 25% N(Urea)	1.60	1.43	1.39
T_{13}	Absolute control	1.45	1.35	1.30
	SE ±	0.151	0.094	0.087
	C.D.(P=0.05)	NS	NS	NS

At the harvest stage the available Zn ranged between 0.89 to 2.08 mg kg^{-1}. There is a slight decrease in Zn content as compared to previous stage i.e. 60 DAT. Maximum available Zn (1.53 mg kg^{-1}) was recorded by treatment T_6 receiving 75 per cent N through vermicompost and 25 per cent N through urea and lowest value of available Zn (1.30 mg kg^{-1}) was recorded in treatment T_{13} (Absolute control). Similar trends and ranges were also reported by Kokare (2013)

From the above result it is clear that application of organic manures increases the available Zn content in soil. It might be due to the reaction of organic matter with micronutrients exhibited in the soil, solubilization and mobilization by short chain organic acids and bases and complexation by initially soluble organic substances, which then form insoluble salts as suggested by Tisdale (1993).

4.6.10 DTPA Extractable Copper

The available Cu content of soil at 30, 60 DAT and at harvest is presented in Table 30 and depicted in fig 16. It was observed from the data that the available Cu content at 30, 60 DAT and at harvest ranged from 3.67 to 5.69 mg kg^{-1}, 5.08 to 7.67 mg kg^{-1} and 2.36 to 3.95 mg kg^{-1} respectively, which was found to be statistically non-significant.

Table 30: Effect of different sources of organic manures and their combination on DTPA Extractable Copper.

Tr. No.	Treatment Details	DTPA Extractable Cu (mg kg^{-1})		
		30 DAT	60 DAT	At harvest

T_1	25% N(FYM) + 75% N(Urea)	3.92	5.61	3.12
T_2	50% N(FYM) + 50% N(Urea)	3.86	5.85	2.50
T_3	75% N(FYM) + 25% N(Urea)	3.93	6.07	3.00
T_4	25% N(VC) + 75% N(Urea)	4.67	6.67	2.88
T_5	50% N(VC) + 50% N(Urea)	5.69	6.36	3.78
T_6	75% N(VC) + 25% N(Urea)	4.43	7.17	3.02
T_7	25% N(PM) + 75% N(Urea)	4.12	7.03	2.42
T_8	50% N(PM) + 50% N(Urea)	4.22	7.67	3.95
T_9	75% N(PM) + 25% N(Urea)	3.76	6.56	3.13
T_{10}	25% N(GC) + 75% N(Urea)	3.67	6.58	2.88
T_{11}	50% N(GC) + 50% N(Urea)	4.64	5.95	2.89
T_{12}	75% N(GC) + 25% N(Urea)	4.07	6.56	3.43
T_{13}	Absolute control	5.10	5.08	2.36
	SE ±	0.53	0.88	0.66
	C.D.(P=0.05)	NS	NS	NS

At 30 DAT, the highest value (5.69 mg kg^{-1}) of available Cu was found in treatment T_5 receiving 50 per cent N through vermicompost and 50 per cent N through urea and lowest value (3.67 mg kg^{-1}) of available Cu was found in treatment T_{10} receiving 25 per cent N through groundnut cake and 75 per cent N through urea.

At 60 DAT, the highest available Cu (7.67 mg kg^{-1}) was found in treatment T_8 receiving 50 per cent N through poultry manure and 50 per cent N through urea and lowest value of available Cu (5.08 mg kg^{-1}) was recorded in treatment T_{13} (Absolute control).

At the harvest stage of the crop available Cu ranged between 2.36 to 3.95 mg kg^{-1} there is a slight decrease in Cu content as compared to previous stage i.e. 60 DAT. Maximum available Cu (3.95 mg kg^{-1}) was recorded by treatment T_8 receiving 50 per cent N through poultry manure and 50 per cent N through urea and lowest value of available Cu (2.36 mg kg^{-1}) was recorded in treatment T_{13} (Absolute control). Similar trends and ranges were also reported by Kokare (2013).

The increase in available micronutrient status of soils in organically treated plots might be due to release of chelating agent from organic matter decomposition which might have prevented micronutrients from precipitation, oxidation and leaching reported by Sharma *et al.* (2001). There is reduction in micronutrient content in the treatment receiving only inorganic fertilizers. It was attributed to non-replacement of micronutrients through chemical fertilizers these results are in agreement with the finding of Katyal and Sharma (1979).

CHAPTER V

SUMMARY AND CONCLUSION

The investigation entitled "Effect of different sources of organic manure and their combination on yield and nutrient uptake by chilli (*Capsicum annum* L.) in lateritic soil of Konkan" was conducted at Vegetable Improvement Scheme, Pangari Block of CES, Wakawali and analysis was done at Central Instrumentation Center, Department of Soil Science and Agricultural Chemistry, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli during the year 2014-15.

The field experiment was laid out in a randomized block design comprising of thirteen treatments with three replications. Different sources of organic manures viz., farm yard manure, vermicompost, poultry manure and groundnut cake and their combination with inorganic fertilizers were tried on performance of chilli crop. The study was undertaken to evaluate the effect of different sources of organic manure and their combination on chilli crop during *rabi* season on lateritic soils of Konkan. The important findings that have emerged from the present investigation are summarized in this chapter.

5.1 Effect on Growth and yield contributing characters

5.1.1 Plant height

Application of plant nutrients through various sources of organic manures combined with inorganic fertilizers increased the plant height significantly at 30 DAT, but plant height at 60 DAT and at harvest did not reach the levels of significance due to several treatments. The maximum plant height at 30 DAT (30.12cm), 60 DAT (44.53 cm) and at harvest (48.76 cm) was recorded in treatment T_9 receiving 75 % N through Poultry manure and 25 per cent N through urea.

5.1.2 Weight of fruit (g plant^{-1})

The fresh fruit weight was maximum (345.63 g plant^{-1}) in treatment T8 receiving 50 % N through Poultry manure and 50 per cent N through urea. Minimum fruit weight (198.87 g plant^{-1}) was recorded in treatment T_{13} (Absolute control).

5.2 Effect on chilli pod and Stover yield.

5.2.1 Effect on green chilli pod yield

The application of different sources of organic manures and their combination on chilli significantly influenced the yield of green chilli as well as stover. Highest green pod yield of chilli (128.01 q ha^{-1}) was recorded in the treatment T_8 receiving 50 per cent N through poultry manure and 50 per cent N through urea.

5.2.2 Effect on dry matter yield of green chilli pods.

Dry matter yield of green chilli pod is significantly influenced by various treatments and ranged between 11.22 q ha^{-1} to 5.73 q ha^{-1}. Maximum dry matter yield of green chilli pod (11.22 q ha^{-1}) was recorded in treatment T_8 receiving 50 per cent N through Poultry manure and 50 per cent N through urea.

5.2.3 Effect on stover yield of chilli

Stover yield of chilli was found to be a significant. Numerically higher stover yield (15.28 q ha^{-1}) was obtained by treatment T_8 receiving 50 per cent N through Poultry manure and 50 per cent N through urea.

5.3 Effect on nutrient content in plant and green chilli pod.

5.3.1 Effect on nitrogen content.

5.3.1.1 Nitrogen content in chilli plant.

The nitrogen content in chilli plant at 30 DAT, 60 DAT and at harvest was significantly influenced by the various treatments. It increased from 1.06 to 1.98 per cent, 1.57 to 2.16 per cent and 1.11 to 1.43 per cent in all treatments at 30, 60 DAT and at harvest, respectively. Maximum N content at 30 DAT (1.98%), at 60 DAT (2.16%) and at harvest (1.43%) was found in treatment T_8 (50 % N through poultry manure + 50

% N through urea) which was significantly highest over rest of the treatments.

5.3.1.2 Nitrogen content in green chilli pod

It reveals that at harvest stage, the highest N content in pod (1.68%) was contributed by treatment T_8 receiving 50 per cent N through poultry manure and 50 per cent N through urea.

5.3.2 Effect on Phosphorus content

5.3.2.1 Phosphorous content in chilli plant

Phosphorus content in chilli plant at 30, 60 DAT and at harvest was significantly affected due to various treatments and it is ranged from 0.05 to 0.12 per cent at 30 DAT, 0.08 to 0.14 per cent at 60 DAT and 0.06 to 0.13 per cent at harvest. Maximum P content at 30 DAT (0.12%), at 60 DAT (0.14%) and at harvest (0.13%) was found in treatment T_5 (50 % N through Vermicompost + 50 % N through Urea)

5.3.2.2 Phosphorous content in green chilli pod.

At harvest stage, the P content in green chilli pod was significantly affected due to various treatments and it is ranged from 0.12 to 0.18 per cent. The highest P content in pod (0.18 %) was contributed by T_8 receiving 50 per cent N through poultry manure and 50 per cent N through urea.

5.3.3 Effect on Potassium content.

5.3.3.1 Potassium content in chilli plant

The potassium content in chilli plant at 30, 60 DAT and at harvest was significantly affected due to various treatments and it ranged from 3.13 to 5.03 per cent at 30 DAT, 4.12 to 5.12 per cent at 60 DAT and 2.06 to 4.52 per cent at harvest. Maximum K content at 30 DAT (5.03%) and at 60 DAT (5.12%) was found in treatment T_8 (50 % N through Poultry manure + 50 % N through Urea) and at harvest maximum K content

(4.52%) was found in treatment T_6 receiving (75% N through Vermicompost + 25 % N through Urea).

5.3.3.2 Potassium content in green chilli pod.

At harvest stage, the K content in green chilli pod was significantly affected due to various treatments and it ranged from 1.93 to 3.20 per cent. The highest K content in pod (3.20 %) was contributed by T_8 receiving 50 per cent N through poultry manure and 50 per cent N through urea.

5.3.4 Effect on Iron content

5.3.4.1 Iron content in chilli plant

The variation in the Fe content due to various treatments in chilli plant was found to be non-significant at all three stages i.e. 30, 60 days after transplanting and at harvest. It ranged from 29.87 to 43.38 mg kg^{-1} at 30 DAT, 31.24 to 39.95 mg kg^{-1} at 60 DAT and 29.30 to 35.81 mg kg^{-1} at harvest. Maximum Fe content at 30 DAT (43.38 mg kg^{-1}), at 60 DAT (39.95 mg kg^{-1}) and at harvest (35.81 mg kg^{-1}) was found in the Treatment T6 (75 % N through Vermicompost + 25 % N through Urea) and lowest Fe content was found in treatment T_{13} (Absolute control) at all stages.

5.3.4.2 Iron content in green chilli pod.

At harvest stage, the Fe content in green chilli pod was significantly affected due to various treatments and it is ranged from 11.43 to 21.03 mg kg^{-1}. The highest Fe content in pod (21.03 mg kg^{-1}) was contributed by T_8 receiving 50 per cent N through poultry manure and 50 per cent N through urea.

5.3.5 Effect on Manganese content

5.3.5.1 Manganese content in chilli plant

The variation in the Mn content due to various treatments in chilli plant was found to be non-significant at 30, 60 days after transplanting and significant at harvest. It ranged from 114.73 to 217.80 mg kg^{-1} at 30

DAT, 99.20 to 171.15 mg kg^{-1} at 60 DAT and 88.3 to 161.49 mg kg^{-1} at harvest. Maximum Mn content at 30 DAT (217.80 mg kg^{-1}) and at harvest (161.49 mg kg^{-1}) was found in treatment T_8 (50 % N through Poultry manure + 50 % N through Urea). At 60 DAT maximum Mn content (171.15 mg kg^{-1}) was found in treatment T_6 receiving (75 % N through Vermicompost + 25 % N through Urea) but it was found to be statistically non-significant.

5.3.5.2 Manganese content in green chilli pod.

At harvest stage, the Mn content in green chilli pod was non-significantly affected due to various treatments and it is ranged from 33.91 to 50.11 mg kg^{-1}. The highest Mn content in pod (50.11 mg kg^{-1}) was contributed by T_6 receiving 75 per cent N through vermicompost and 25 per cent N through urea and the lowest Mn content (33.91 mg kg^{-1}) was found in treatment T_{13} (Absolute control).

5.3.6 Effect on Zinc content

5.3.6.1 Zinc content in chilli plant

The variation in the Zn content due to various treatments in chilli plant was found to be non-significant at all three stages i.e. 30, 60 days after transplanting and at harvest. It ranged from 32.27 to 60.83 mg kg^{-1} at 30 DAT, 40.57 to 82.27 mg kg^{-1} at 60 DAT and 27.10 to 61.33 mg kg^{-1} at harvest. Maximum Zn content was observed in treatment T8 (60.83 mg kg^{-1}), T8 (82.27 mg kg^{-1}), T6 (61.33 mg kg^{-1}) at 30, 60 days after transplanting and at harvest respectively and minimum Zn content was observed in treatment T_{13} (32.27 mg kg^{-1}), T_{13} (40.57 mg kg^{-1}) and T_{13} (27.10 mg kg^{-1}) at 30, 60 DAT and at harvest respectively.

5.3.6.2 Zinc content in green chilli pod.

At harvest stage, the Zn content in green chilli pod was found to be non-significant due to various treatments and it ranged from 33.43 to 43.00 mg kg^{-1}. The highest Zn content in pod (43.00 mg kg^{-1}) was contributed by T_6 receiving 75 per cent N through vermicompost and 25 per cent N through urea and the lowest Zn content (33.43 mg kg^{-1}) was found in treatment T_{13} (Absolute control).

5.3.7 Effect on Copper content

5.3.7.1 Copper content in chilli plant

The variation in the Cu content due to various treatments in chilli plant was found to be non-significant at all the three stages i.e. 30, 60 days after transplanting and at harvest. It ranged from 38.60 to 59.70 mg kg^{-1} at 30 DAT, 75.13 to 87.57 mg kg^{-1} at 60 DAT and 27.83 to 68.10 mg kg^{-1} at harvest. Maximum Cu content was observed in treatment T_{12} (59.70 mg kg^{-1}), T_{12} (87.57 mg kg^{-1}), T_{10} (68.10 mg kg^{-1}) at 30, 60 days after transplanting and at harvest respectively and minimum Cu content was observed in treatment T_2 (38.60 mg kg^{-1}), T_5 (75.13 mg kg^{-1}) and T_5 (27.83 mg kg^{-1}) at 30, 60 DAT and at harvest respectively.

4.3.7.2 Copper content in green chilli pod.

At harvest stage, the Cu content in green chilli pod was non-significantly affected due to various treatments and it ranged from 33.40 to 64.20 mg kg^{-1}. The highest Cu content in pod (64.20 mg kg^{-1}) was contributed by T_5 receiving 50 per cent N through vermicompost and 50 per cent N through urea, and the lowest Cu content (33.40 mg kg^{-1}) was found in treatment T_7.

5.4 Effect on uptake of nutrient by chilli

5.4.1 Nitrogen uptake

The uptake of nitrogen by the stover, chilli pod and total uptake vary from 9.13 to 18.38 kg ha^{-1}, 6.89 to 18.35 kg ha^{-1} and 16.02 to 36.08 kg ha^{-1} respectively due to effect of various treatments and it was found to be statistically significant. Among the various treatments the maximum uptake of nitrogen by stover (18.38 kg ha^{-1}) chilli (18.35 kg ha^{-1}) and total N uptake (36.08 kg ha^{-1}) was recorded in treatment T_8 with application of 50% N through poultry manure and 50% N through urea, which was significantly higher over rest of other treatments.

5.4.2 Phosphorus uptake

The uptake of phosphorus by the stover, chilli pod and total uptake varied from 0.45 to 1.43 kg ha^{-1}, 0.71 to 1.97 kg ha^{-1} and 1.16 to 3.40 kg ha^{-1} respectively due to effect of various treatments and it was found to be statistically significant. Among the various treatments the maximum uptake of phosphorus by stover (1.43 kg ha^{-1}) chilli (1.97 kg ha^{-1}) and total P uptake (3.40 kg ha^{-1}) was recorded in treatment T_8 with application of 50% N through poultry manure and 50% N through urea, which was significantly higher over rest of other treatments.

5.4.3 Potassium uptake

The uptake of potassium by the stover, chilli pod and total uptake varied from 16.99 to 51.11 kg ha^{-1}, 11.03 to 34.89 kg ha^{-1} and 28.02 to 74.58 kg ha^{-1} respectively due to effect of various treatments and it was found to be statistically significant. Among the various treatments the maximum uptake of potassium by stover (51.11 kg ha^{-1}), chilli (34.89 kg ha^{-1}) was recorded in treatment T_9 and T_8 respectively. Which ware significantly higher over rest of other treatments. The maximum total K uptake (74.58 kg ha^{-1}) was recorded with treatment T_9 i.e. application of 75% N through poultry manure and 25% N through urea.

5.4.4 Iron uptake

The data reveals that the uptake of Fe in the stover varied from 255.47 to 474.87 g ha^{-1} due to effect of various treatments. But it was found to be non-significant.

The uptake of Fe by the chilli pod was increased from 65.32 to 229.77 g ha^{-1} due to effect of various treatments. It was significantly higher than the other treatments over control. Among the various treatments the maximum (229.77 g ha^{-1}) uptake of Fe was recorded with treatment T_8 receiving 50% N through poultry manure and 50% N through urea. The total uptake of iron by the chilli plant due to various treatment varied non-significantly from 320.79 to 637.95 g ha^{-1}. The maximum uptake (637.95 g ha^{-1}) was recorded in the treatment T_9 receiving 75% N through poultry manure and 25% N through urea. Minimum uptake (320.79 g ha^{-1}) was recorded at treatment T_{13} (absolute control).

5.4.5 Manganese uptake

Mn uptake by stover varied significantly and ranged between 701.59 to 1991.29 g ha^{-1}.The treatment T_8 receiving 50% N through poultry manure and 50% N through urea was recorded significantly highest value (1991.29 g ha^{-1}) over rest of the treatments. Mn uptake by chilli pod ranged from 192.89 to 516.22 g ha^{-1}. The maximum Mn uptake was recorded by treatment T_6 (516.22 g ha^{-1}) but which was found to be non-significant.

Total Mn uptake by chilli plant varied significantly and ranged between 894.48 to 2434.36 g ha^{-1}. The treatment T_8 receiving 50% N through poultry manure and 50% N through urea was recorded significantly highest value (2434.36 g ha^{-1}) over rest of the treatments. Minimum Mn uptake was observed in treatment T_{13} control at all stages.

5.4.6 Zinc uptake

The uptake of Zn by the stover and chilli pod varied from 220.35 to 720.05 g ha^{-1} and 191.86 to 443.53 g ha^{-1} respectively due to effect of various treatments. It was found to be non-significant. Among the various treatments the maximum uptake of Zn by stover (720.05 g ha^{-1}) and chilli pod (443.53 g ha^{-1}) was recorded with treatment T_1 and T_7 respectively Minimum uptake was recorded at treatment T_{13} (absolute control).

The total uptake of Zinc by the chilli plant due to various treatments ranged from 412.21 to 1041.31 g ha^{-1} and differed significantly. The maximum uptake (1041.31 g ha^{-1}) was recorded in the treatment T_9 receiving 75% N through poultry manure and 25% N through urea. Minimum uptake (412.21 g ha^{-1}) was recorded at treatment T_{13} (absolute control).

5.4.7 Copper uptake

The uptake of copper by the stover, chilli pod and total uptake varied from 346.53 to 719.40 g ha^{-1}, 196.44 to 654.04 g ha^{-1} and 542.97 to 1259.12 g ha^{-1} respectively due to effect of various treatments and it was found to be statistically non-significant.

5.5 Effect on quality of chilli.

5.5.1 Effect on ascorbic acid content.

The maximum ascorbic acid content (78.33 mg 100 g^{-1}) and significantly superior value than rest of all treatment was reported in T_{10} receiving 25% N through groundnut cake and 75% N through urea. And T_{13} control reported minimum value 30.17 mg 100 g^{-1}.

5.5.2 Effect on capsaicin content in chilli pod.

The capsaicin content in chilli pod at harvest ranged in between 0.10 % to 0.31 %. The highest capsaicin content was recorded in treatment T_8 receiving 50% N through poultry manure and 50% N through urea.

5.6 Effect on chemical properties of soil

5.6.1 Effect on soil pH:

The pH of soil at 30 DAT and at harvest was not significantly influenced by various treatments. Only at 60 DAT it was significantly influenced by various treatments. At 60 DAT, the pH was significantly affected due to different treatments, the highest pH (6.22) was recorded in treatment T_9 receiving 75% N through poultry manures and 25% N through urea.

5.6.1 Effect on soil EC:

The EC of soil at 30, 60 DAT and at harvest was not significantly influenced by various treatments. The values were ranged between 0.13 to 0.18 dSm^{-1}, 0.12 to 0.23 dSm^{-1} and 0.11 to 0.17 dSm^{-1} at 30, 60 DAT and at harvest respectively.

5.6.1 Effect on soil Organic carbon:

The Organic Carbon of soil at 30 DAT was showed significant effect. Highest OC of soil (16.77g kg^{-1}) was recorded in treatment T_1 receiving 25 per cent N through FYM and 75 per cent N through urea. At 60 DAT and at harvest, the OC of soil was not significantly affected due to the different treatment.

5.6.4 Available nitrogen

The available nitrogen content in soil at 30 DAT, 60 DAT and at harvest was significantly influenced by the various treatments. It ranged from 139.03 to 205 kg ha^{-1}, 147.39 kg ha^{-1} to 223.70 kg ha^{-1} and 103.49 kg ha^{-1} to 172.48 kg ha^{-1} in all treatments at 30, 60 DAT and at harvest respectively. Maximum available N content at 30 DAT (205 kg ha^{-1}), at 60 DAT (223.70 kg ha^{-1}) and at harvest (172.48 kg ha^{-1}) was found in treatment $T_{12,}$ T_8 and T_8 It is also observed that the content of available nitrogen was increased up to 60 DAT and later on decreased at harvest of chilli crop.

5.6.5 Available phosphorus

Available Phosphorus content in soil at 30, 60 DAT and at harvest was significantly affected due to various treatments and it ranged from 6.08 kg ha^{-1} to 23.14 kg ha^{-1} at 30 DAT, 2.37 kg ha^{-1} to 13.27 kg ha^{-1} at 60 DAT and 3.32 kg ha^{-1} and 20.46 kg ha^{-1} at harvest. Maximum available phosphorus content at 30 DAT (23.14 kg ha^{-1}), at 60 DAT (13.27 kg ha^{-1}) and at harvest (20.46 kg ha^{-1}) was found in treatment T_5 (50 % N through Vermicompost + 50 % N through Urea) which was significantly highest over the rest of the treatments.

5.6.6 Available potassium

The available potassium content in soil at 30, 60 DAT and at harvest was significantly affected due to various treatments and it is ranged from 262.93 to 510.72 kg ha^{-1} at 30 DAT, 351.58 to 718.19 kg ha^{-1} at 60 DAT and 303.74 kg ha^{-1} to 605.25 kg ha^{-1} at harvest. Maximum K content at 30 DAT (510.72 kg ha^{-1}) and at 60 DAT (718.19 kg ha^{-1}) and at harvest (605.25 kg ha^{-1}) was found in treatment T_{11} (50 % N through groundnut cake + 50 % N through urea) which was significantly highest over rest of the treatments. It was also observed from data that the content of available potassium increased at 60 DAT and later on decreased at harvest of chili crop.

5.6.7 DTPA Extractable iron

The available Fe content of soil at 30, 60 DAT and at harvest was found to be non-significant due to effect of different treatments. The Fe content values in soil ranged from 27.80 to 45.30 mg kg^{-1}, 26.73 to 42.49 mg kg^{-1} and 23.67 to 39.47 mg kg^{-1} at 30, 60 days after transplanting and at harvest, respectively.

5.6.7 DTPA Extractable manganese

There was no significant variation in available Mn content of soil at 30, 60 DAT and at harvest due to effect of different treatments. The values of available Mn content in soil was ranged from 90.73 to 119.07 mg kg^{-1}, 94.70 to 123.87 mg kg^{-1} and 99.73 to 116.27 mg kg^{-1} at 30, 60 days after transplanting and at harvest, respectively.

5.6.7 DTPA Extractable zinc

The available Zn content at 30, 60 DAT and at harvest ranged from 1.45 to 2.03 mg kg^{-1}, 1.35 to 1.61 mg kg $^{-1}$, and 1.30 to 1.53 mg kg $^{-1}$ respectively, which was found statistically non-significant

5.6.7 DTPA Extractable copper

The available Cu content at 30, 60 DAT and at harvest ranged from 3.67 to 5.69 mg kg^{-1}, 5.08 to 7.67 mg kg $^{-1}$ and 2.36 to 3.95 mg kg $^{-1}$ respectively, which was found statistically non-significant.

CONCLUSIONS:

On the basis of results summarized as above, the following conclusion can be drawn.

The growth contributing character as indicated by plant height [at 30 DAT (30.12cm), 60 DAT (44.53 cm) and at harvest (48.76 cm)] and weight of fruit (345.63 g plant^{-1}) improved with combined application of poultry manure and urea.

Substitution of N through poultry manure to the extent of 50 per cent (and remaining 50 per cent through urea +50 kg P_2O_5 +50 kg K_2O) was observed to be the best treatment amongst different combinations of organic manures with urea. It produced highest green pod yield (128.01 q ha^{-1}), dry matter yield of green pod (11.22 q ha^{-1}) and stover yield (15.28 q ha^{-1}) of chilli.

The NPK uptake by pod and stover was also recorded maximum in combined application of poultry manure with urea. Maximum uptake of N (36.08 kg ha^{-1}) and P (3.40 kg ha^{-1}) was recorded with treatment T_8 i.e. application of 50% N through poultry manure and 50% N through urea while the maximum uptake of K (74.58 kg ha^{-1}) was recorded with treatment T_9 i.e. application of 75% N through poultry manure and 25% N through urea.

The quality parameter as indicated by ascorbic acid (78.33 mg 100 g^{-1}) and capsaicin content (0.31%) at harvest was improved with the combined application of groundnut cake (25% N through groundnut cake and 75% N through urea) and poultry manure (50% N through poultry manure and 50% N through urea) with urea respectively.

As far as the nutrient availability was concerned, at harvest maximum amount of available nitrogen (172.48 kg ha^{-1}) was recorded in treatment T_8 receiving 50 per cent through poultry manure and 50 per cent N through urea. At 30, 60 DAT and at harvest, the highest availability of phosphorus and potassium in soil was recorded in treatment T_5 (50 per cent through vermicompost and 50 per cent N through urea) and T_{11} (50 per cent N through groundnut cake and 50 per cent N through urea) respectively.

It could be concluded from the above investigation that the application of 100 % RDN through different combination of poultry manure with urea (50 per cent through poultry manure and 50 per cent N through urea, 75 per cent N through poultry manure and 25 per cent N through urea) was found to be the best treatments along with recommended dose of phosphorus and potassium in increasing yield (stover and pod) of chilli, Var. Konkan Kirti as well as improving the soil properties. The present investigation has clearly indicated that for sustaining soil fertility and productivity use of organic in combination with inorganic fertilizer is very much beneficial.

These conclusion are based on one season data and for confirmation the investigation needs to be further studied.

LITERATURE CITED

Ademoyegun, O. T., Fariyike T. A. and Aminu-Taiwo R.B. (2011). Effects of poultry dropping on the biologically active compounds in *capsicum annuum* L. (var. Nsukka Yellow). *Agric. Biol. J. N. Am.,* **2** (4): 665-672.

Alabi, D. A. (2006). Effects of fertilizer phosphorus and poultry droppings treatments on growth and nutrient components of pepper (*Capsicum annuum* L.). *African Journal of Biotechnology* **5**, 671-677.

Anathi, S., Veeraragavathatham D. and Srinivasan K. (2004). Influence of sources and levels of potassium on quality attributes of chilli (*Capsicum annuum* L.). *South Indian Horticulture,* **52** (1-6):152-157.

Anonymous (1990). Soils Research Bulletin-2. Konkan Krishi Vidyapeeth, Dapoli. pp: 2.

Anonymous (2015). Report of Indian Horticulture Database 2014, crop-wise area, production and productivity of major spice crops in India during 2013-14: 6-7

Badole, S. B. and More, S. D. (2000). Soil organic carbon status as influenced by organic and inorganic nutrient sources in Vertisol. *J.Maha. agric. Univ.,* **25**(2): 220-222.

Bagal (2009). Efficacy of formulations of briquettes containing nitrogen, phosphorus, potassium, zinc and UB-DAP on yield, nutrient uptake by rice (*Oryza sativa*) and on soil properties. M. Sc. (Agri.) Thesis submitted to Dr. B. S. K. K. V., Dapoli. India (M. S). (Unpublished)

Bhandari, A.N., Anil Sood, Sharma, K. N., and Rana, D. S. (1992) Integrated nutrient management in a rice-wheat system. *J. Indian soc. Soil Sci.*, **40**: 742-746.

Black, C.A. (1965). Method of Soil Analysis Part-II. *Am. Agron. Inc. Madison* Wisconsin*,* U.S.A. pp. 1040-41, 1374-75.

Bouyoucos, G. J. (1951). A recalibration of the hydrometer method for making mechanical analysis of soil. *Agron. J.* **43**(3):435-438.

Chavan, P. J., Syad Ismail, Rudraksha, G. B., Malewar, G. U. And Baig, M. I. (1997). Effect of various Nitrogen levels through FYM and urea on yield, uptake of nutrients and ascorbic acid content in chilli (*Capsicum annuum* L.). *J. Indian Soc. Soil Sci.* **45**(4): 833-835.

Ching Fang, H. and Kvonon, H. (1994) Effect of organic manures on the growth and yield of sweet pepper. *Bull. Juching District Agric. Improv. Stat.*, **42**: 1-10.

Chinnaswami, K.N. (1967). *Madras Agric. J.*, **54**: 144-146.

Chinnaswami, K.N. and Mariakulandai, A. (1966). *South Indian Hort.*, **14**: 36-42.

Chopra, S. L. and Kanwar, J. S. (1978). Analytical Agricultural Chemistry, Kalyani Publisher, Ludhiana, New Delhi, pp. 344.

Dademal, A.A. and Dongale, J.H., 2004, Effect of manures and fertilizers on growth and yield of okra and nutrient availability in latertic soil of Konkan. *J. Soils and Crops,* **14**(2):278-283.

Dileep S. N. and Sasikala, S. (2015). Studies on the effect of different organic and inorganic fertilizers on growth, fruit characters, yield and quality of chilli (*Capsicum annuum* L.) cv. K-1. *International Journal of Agricultural Sciences,* Vol. **5**(1): 229-232.

Dodla (2008) Effect of inm on yield, nutrient uptake and quality of chilli (cv. Byadgi Dabbi) in a vertisol. M. Sc. (Agri.) Thesis submitted to U. A. S. Dharwad Karanataka India. (Unpublished)

Dutta, M. and Sangtam, R. (2014). Integrated Nutrient Management on Performance of Rice in Terraced Land. International Journal of Bio-resource and Stress Management **5**, 107-112.

Frank, G. V. (1965). The plant needs for and use of nitrogen in soil. Edited by Bartaacorew W. U. Francis, E. C. Amer. Soc. of Agronomy. Inc. U. S. A. pp. 58-509

Ghuman, B. S. and Sur, H. S. (2006). Effect of manuring on soil properties and yield of rainfed wheat. *J. Indian Soc. Soil Sci.* **54**(1): 6-11.

Gupta, A. P., Anil R. S. and Narwal, R. P. (1988). Effect of FYM on organic carbon, N and P content of soil during different periods of *wheat growth. J. Indian Soc, Soil.* **36**(2):269-273.

Hangarge, D. S., Raul, R. S., Gaikwad, G. H., Adsul, P. B. and Dixit, R.S. (2004). Influence of vermiocmpost and other organics on fertility and productivity of soil under chilli Spinach cropping system. *J. Soils and Crops,* **14**(1): 181-186.

Harikrishna, B. L., Channal, H. T., Hebsur, N. S., Dharmatti, P. R. and Sarangamath, P. A. (2002). Integrated nutrient management (INM) on availability of nutrients, uptake and yield of tomato. *Karnataka J. Agric. Sci.* **15**(2): 275-278.

Heitkamp, F., Raupp, J. and Ludwig, B. (2011). Soil organic matter pools and crop yields as affected by the rate of farmyard manure and use of biodynamic preparations in a sandy soil. *Organic Agriculture* **1**, 11-124

Hiraguli, P.S. and Allolli T.B. (2012). Effect of organic, inorganic and bio-fertilizers on nutrient uptake and productivity of byadagi chilli. *International Journal of Agricultural Sciences*. **8**(1): 191-193.

Ikeh, A. O., Ndaeyo, N. U., Uduak, I. G., Iwo, G. A., Ugbe, L. A., Udoh, E. I. and Effiong G. S. (2012). Growth and yield responses of pepper (*Capsicum frutescens* L.) to varied poultry manure rates in Uyo, southeastern Nigeria. *ARPN Journal of Agricultural and Biological Science* **7**(9):735-742.

Ismail, C.S. (1997). *J. Indian Soc. Soil Sci.*, **45**: 833-835.

Jackson, M. L. (1973). Soil chemical analysis. Prentice Hall of India Pvt. Ltd., New Delhi. pp. 134-182.

Jasvir Singh, B., Sree Krishna, B. and Sundharaman, M. R. (1997). Performance of Scotch bonnet chilli in Karnataka and its response to vermicompost. Indian Cocoa, *Arecanut and Species J.* **21**:9-10.

Jayanthi, L., Sekar, J., Ameer Basha, S. and Parthasarathi, K. (2014). Influence of Vermifertilizer on Soil Quality, Yield and Quality of Chilli (*Capsicum annuum* L.). *International Inter disciplinary Research Journal.* **4**: 204-217.

John, P. S. and George, M. (1991). Nutrient balance and sustainable agriculture in west coast plains and Ghat region, *Ferti. News.* **36**(6):59-65.

Jones, L. P. M. (1983). Plant soil. 141.

Kadam, J. R., Sahane, J. S. and Kareppa, S. M. (2005). Effect of NPK Briquette on movement and availability of nutrients and yield of Tomato. *J. Maharashtra Agric. Univ.,* **30**(2):131-134.

Kale, R. D. and Bano, K. (1988). Field trials with vermicompost (Vee comp E.83 UAS) on organic fertilizer. In: *Proc. Nation. Sem. on Organic Waste Utilization Vermicompost,* Part B: Verms and Vermicompsot (eds.) pp.151-157.

Kale, R. D., Bano, K., Sunitha, N. and Gangadhar, H. S. (1994). Consolidated Tech. Rep. Adhoc scheme on promotion of vermicomposting for production of organic fertilizers sponsored by ICAR, New Delhi. Uni. Agric. Sci. Banglore.

Kaminwar, S. P. and Rajagopal, V. (1993). Fertilizer response and nutrient requirement of rainfed chillies in Andhra Pradesh. *Fert. News,* **36**(7): 21-26.

Kanan, P. A., Saravanan and Balaji, T. (2006). Organic farming on tomato yield and quality. *Crop Res.* **32**(2):196-200.

Kasture (2001). Effect of phosphorous and sulphur on yield and uptake of nutrient by chilli (*Capsicum annuum* L.) on lateritic soils of Konkan. M. Sc. (Agri.) Thesis submitted to Dr. B. S. K. K. V., Dapoli. India (M. S). (Unpublished)

Kattimani, S. (2004). Response of chilli (*Capsicum annuum* L.) genotypes to integrated nutrient management. M. Sc. (Agri.) Thesis submitted to U. A. S. Dharwad, Karnataka, India. (Unpublished)

Katyal, J. C. and Sharma, D. D. (1979). Role of micronutrients in crop production. Fert. News, **24**: 33-50.

Kokare (2013).Comparative efficacy of different fertilizer briquettes and organic manures on chilli (*Capsicum annuum* L. cv. Pusa Jwala) in lateritic soils of Konkan. M.Sc. (Agri.) Thesis submitted to D. B. S. K. K. V. Dapoli, Maharashtra, India. (Unpublished)

Kumar, A. K. (2013). Effect of foliar application of NPK nutrients on growth and yield of chilli (*Capsicum annuum* L.). *The Journal of Research*. Acharya N.G. Ranga Agricultural University 41, 1-4.

Kumar, V., Sachan, C. P., Senjam Jinus Singh and Anjan Kumar Sinha. (2016). Effect of inm practice on plant growth, fruit yield and yield attributes in chilli (*capsicum annuum* L.). *International Journal of Plant, Animal and Environmental Sci.*, **6**(1):170-173.

Lal, S. and Mathur, B. S. (1989). Effect of long term application of manures and fertilizer use on the status of micronutrients in soil and crop. *J. Indian Soc. Soil Sci.*, **37**(3): 588-590.

Lata, S. and Singh, R. P. (1993). Effect of nitrogen level and growth regulators on growth, yield and quality of chilli (*Capsicum annuum* L.) variety Pant C-1. *Veg. Sci.* **20**(1):40-43.

Lindsy, W. L. and Norvell, W. L. (1978). Development of DTPA soil test for Zinc, Iron, Manganese and Copper. Proc. Soil. Sci. Am. **42**(3): 421-428.

Maheswari, T. U., Haripriya, K. and Sivasakthivelan, P. (2015). Studies on the efficacy of combined inoculation of different organic manures and azospirillum bio inoculant in solarized hot pepper nursery. *Life Science Archives (LSA),* **1**(4): 246 – 249.

Malawadi, M. N. (2003). Effect of secondary and micronutrients on yield and quality of chilli (*Capsicum annuum* L.). M. Sc. (Agri.) Thesis submitted to U. A. S. Dharwad, Karnataka, India. (Unpublished)

Malewar, G. U., Syed, I., Rudraksha, G.B., 1998. Integrated Nitrogen Management in chilli (*Capsicum annuum* L.). Bulletin of Indian Institute of Soil Science **2**, 156-163.

Mallanagouda, B., Sulkeri, G. S., Murthy, G. B. and Prathibha, N. C. (1995). Effect of NPK, FYM and companion crops on growth, yield and components of chilli. *Adv. Agric. Res. Indian.* **3:** 58-69**.**

Manjunatha, B. (2006). Impact of farmers organic farming practices on soil properties in Northern dry zone of Karnataka. *M.Sc. (Agri.) Thesis,* Univ. Agric. Sci., Dharwad (India).

Marry, S. S. and R. Balkrishnan, (1990). Effect of irrigation nitrogen and potassium on pod Characters and quality in chilli (*Capsicum annuum* L.) Cv. K. 2 *South Indian Horticulture,* **38**:86-89.

Masud, M.M., Moniruzzaman, M., Rahman, M. M., and Noor, S. (2009). Effect of poultry manure in combination with chemical fertilizers on the yield and nutrient uptake by chilli in the hilly region. *J.Soil.Nature.* **3** (2):24-27.

Mclaren, C. A. and Crawford, M. S. (1950). *Soil Sci. Soc. Amer. J.* **37**:309.

Mujumdar, S. P., Meena, R. L. and Baghel, G. D. S. (2000). Effect of levels of compaction and Potassium on yield and quality of tomato and Chilli crops grown on highly permeable soils. *J. Indian Soc. Soil Sci.* **48**(2): 215-220.

Naidu, D.K., Radder, B.M., Patil, P.L., Hebsur, N.S. and Alagundagi, S.C. (2009). Effect of integrated nutrient management on nutrient uptake and residual fertility of chilli (Cv. byadgidabbi) in a vertisol. *Karnataka Journal of Agricultural Sciences* **22**(2), 306-309

Nair, M. and Peter, K. V. (1990). Organic inorganic fertilizers and their combinations on yield and storage life of hot chilli. *Veg. Sci.* **17**(1): 7-10.

Narasapa, K. E., Reddy, N. and Reddy, V. P. (1985). Effect of nitrogen on chilli *South Indian Horticulture.* ***33***

Natarajan, C. P. (1990). Standardization of nitrogen application of chilli grown under semi dry condition. *South Indian Hort.* 38**(6)**:315-318.

Nathkumar, S. and Veeraragavathatham, D. (1996). Effect of integrated nutrient management on yield and quality of Brinjal (*Solanum melongena* L.) cv. Pir 1. *South Indian Horticulture,* **49** (special).

Pandey, A. K., Gopinath, K. A., Chattacharya, P., Hooda, K. S., Sushil, S. N., Kundu, S., Selvakumar, G. and Gupta, H. S. (2006). Effect of source and rate of organic manures on yield attributes, pod yield and economics of organic garden pea (*Pisum sativum* subsp. *hortense*) in northwest Himalaya. *Indian J. Agric. Sci.* **76**(4):230-234.

Pariari, A. and khan, S. (2013). Integrated nutrient management of chilli (*Capsicum annuum* L.) in Gangetic alluvial plains. *Journal of Crop and Weed* **9**(2), 128-130.

Patil *et al.* (2012) Properties of lateritic soils of Konkan Region of Maharashtra. 8th international symposium on plant-soil interaction at low pH. 18-22 Oct. 2012, Bengaluru India.

Petkov, M. (1964). The effect of manuring with mineral fertilizers on the quality and quality of paprika yields. Grad Lozae Nauka, pp.61-71.

Piper, C. S. (1966). Soil and Plant Analysis, Hans Publisher Mumbai, India. Asian Reprint.

Prasad, J., Srivastava, N. C. and Mathur, B. S. (1982). Available nutrient status of a continuously fertilized and cropped acid soil. J. Indian Soc. Soil Sci., **44** (1): 171-173.

Prasad, R. A. and Singhania, R. A. (1989). Effects of different types of enriched manure and time of incubation on soils properties. *J. Indian Soc. Soil Sci.* **37**: 319-322.

Premsekhar, M. and Rajashree, V. (2009). Influence of organic manures on growth, yield and quality of Okra. *American- Eurasian Journal of Sustainable Agriculture* **3**(1), 6-8.

Puranik, R. B., Ballal, D.K., and Barde, N.K. (1978) Studies on nitrogen forms as affected by long term manuring and fertilization in Vertisols. *J. Indian Soc. Soil Sci.* **26**: 169- 172.

Quagliotti, L. (1971). Effect of Soil moisture and nitrogen level on pungency of berries of (*Capsicum annum* L.). *Hort. Res.* ***11****(1):93-97.*

Rajshree, M., Wandile, Maya, M., Raul Swati, Washimakar, V., and Bharti, S.B. (2005). Residual effect of long-term application of N, P, Zn and FYM on soil properties of Vertisols, yield, protein and oil content of soybean. *J. Soils and Crops*, **15**(1):155-159.

Ranganna, S. (1977). Manual of analysis of fruit and vegetables products. Tata Mc Graw Hill publishing Co. Ltd., New Delhi pp.9-82.

Rani, P. L., Balaswamy, K., Ramachandra Rao, A. and Masthan, S. C. (2015). Evaluation of integrated nutrient management practices on growth, yield and economics of green chilli C.V. Pusa Jwala (*Capsicum annuum* L.) *International Journal of Bio-resource and Stress Management,* **6**(1):076-080.

Rokima, J. and Prasad, B. (1989). Kinetics of N mineralization in calcareous soilas influenced by integrated nutrient supply systems. Journal Indian Soc. Soil Sci. **37**: 670-676.

Samsangheile and Kanaujia, S. P. (2014). Integrated nutrient management for quality production of chilli on acid alfisol. *Annals of Plant and Soil Research* **16**(2): 164-167

Sharma, M. P., Balf, S. V. and Gupta, D. K. (2001). Soil fertility and productivity of rice (*Oryza sativa* L.)-wheat (*Triticum aestivum* L.) cropping system in an inceptisol as influenced by Integrated Management. *Indian Agric. Sci.,* **71**(2): 82-86.

Shashidhara, G. B. (2000). Integrated nutrient management in chilli (*Capsicum annuum* L.) Northern Transitional Zone of Karnataka. *Ph.D., Thesis,* Univ. Agric. Sci. Dharwad. India. (Unpublished)

Shende, S. V. (2010). Response of gypsum and lime to Kharif groundnut (*Arachis hypogaea* L.) in lateritic soil of Konkan region. M.Sc.

(Agri.) Thesis submitted to Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli. India (M. S). (unpublished)

Shshidhara, G. B. and Shivamurthi, D. (2008). Studies on the Effect of Integrated Nutrient Management on Growth, Yield and Yield Parameters of Chilli Genotypes under Vertisol of North Transition Zone of Karnataka. *Karnataka J. Agric. Sci.*, **21**(3): 433-435.

Singh, C. K., Suchit A. John and Devansu Jaiswal. (2014). Effect of organics on growth, yield and biochemical parameters of chilli (*Capsicum annum* L.). *IOSR J. of Agri. and Veterinary Sci.* Volume **7**, Issue 7 Ver. II, PP 27-32.

Singh, D., P. K. Chhonkar and R. N. Pandey (1999). Soil Plant Water Analysis - A methods manual. Indian Agricultural Research Institute, New Delhi.

Stroehlein, J. L., Oebker, N. F. (1979). Effects of nitrogen and phosphorus on yields and tissue analysis of chili peppers. *Journal of American Society of Horticultural Sciences* **114**: 559-563.

Subba Rao, T. S. S. and Sankar, C. R. (1998). Effect of organic manures on growth and yield of chilli. *South Indian Horticulture,* **49**(special) 288-191

Subbaiah, K., Helkiah, J., Ravikumar, V. and Gopal, R. (1982). Effect of combined application of organic and inorganic fertilizers on the yield and nutrient uptake of MDV chilli. *South Indian Horticulture,* **30**: 45-47.

Subbiah, B. V. and Asija, G. L. (1956). A rapid procedure for the estimation of available Nitrogen in Soil. *Curr. Sci.* **25**(8):259-260.

Subbiah, K., Helkiah, J. and Rajagopal, C. K. (1980). Effect of nitrogen, phosphorus and potassium on capsaicin content of MDU- 1 Chilli. *South Indian Horticulture.* **28**(2):103-104.

Surender Rao and Sitaramayya, M. (1997) Changes in total and available soil nitrogen status under integrated nutrient management of rice. *J. Indian Soc. Soil Sci.*, **45**(3): 445-449.

Talashilkar, S. C., Dosani, A. A. K., Mehta, V. B. and Powar, A. G. (1997). Integrated use of fertilizers and poultry manure to groundnut crop. *J. Maharashtra agric. Univ.* **22**(2):205-207.

Talpade, N. R., Shinde, P. P. and Nangale, Y. H. (2011). Response of chilli (*Capsicum annuum* L.) to fertigation and poultry manure levels grown under black polythene mulch. *J. Agric Res. Technol.* **36**(3):355-358.

Tambe, A. J., Dhawan, A. S. and Gourkhede, P. H. (2015) Effect of Integrated Nutrient Management on Yield, Quality Improvement and Nutrient Uptake of Chilli. *International Journal of Tropical Agriculture.* **33**(4): 3777-3781.

Tandon, H. L. S. (Ed.). (1993). Methods 0f Analysis of Soils, Plants, Waters and Fertilizers. FDCO, New Delhi, India, pp.24-30, 58-62.

Tisdale, S. L. Nelson, W. L., Beaton, J. D. and Havlin, J. L. (1993). Soil fertility and fertilizers Mac Millan Publ. Co., New York, pp. 634

Tolanur, S. I. and Badanur, V. P. (2003). Changes in organic carbon, available N, P and K under integrated use of organic manure, green manure and fertilizer on sustaining productivity of pearl millet pigeonpea system and fertility of an inceptisol. *J. Indian Soc. soil sci.* **5**(1): 37-41.

Tsuchiya, H. (2001). Biphasic membrane effects of capsaicin, an active component in Capsicum species. *Journal of Ethnopharmacology* **75**, 295–299

Ullah, M. S., Islam, M. S., Islam, M. A. and Haque, T. (2008). Effects of organic manures and chemical fertilizers on the yield of brinjal and soil properties. *J. Bangladesh Agril. Univ.* **6**(2): 271–276.

Vasanthi, D. and Kumarswamy, K. (2000). Effect of manure fertilizer schedules on the yield and uptake of nutrient by cereals fodder crops and on soil fertility. *J. Indian Soc. Soil Sci.*, **48**(3): 510-515.

Venkateshalu, Srinivas, A. G., Sushila Nadagouda and Hanumantharaya, L. (2009). Bio-efficacy of plant product, Stanza against chilli thrips, Scirtothrips dorsalis Hood and chilli mite, Polyphagotarsonemus latus (Banks). Karnataka *J. Agric. Sci.,* **22** (3-Spl. Issue): (559-560)

Vimala, P., Melor, R., Ahmad Shokri, O., and Balasubramaniam, P. (2007). Effect of organic and inorganic fertilizers on growth, yield and nutrient content of bird chilli (*Capsicum frutescence* L.). *J. Trop. Agric. And Fd. Sc.* **35**(1): 29-40.

APPENDIX – I

ABBREVIATIONS USED

%	: Per cent
@	: at the rate
^0C	: Degree Celsius
B.D.	: Bulk Density
C.D.	: Critical Difference
Ca	: Calcium
cm	: Centimeter(s)
Cu	: Copper
Cv.	: Cultivar
DAF	: days after flowering
DAP	: Diammonium phosphate
DAS	: days after sowing
DAT	: Days after transplanting
DMP	: dry matter production
dS m^{-1}	: Deci-Siemen per meter
DW	: Dry weight
E.C.	: Electrical conductivity
et.al.	: and others
Fe	: Iron
Fig.	: Figure(s)
FW	: Fresh weight
FYM	: Farm yard manure

g : gram

G. C. : Groundnut cake

g ha^{-1} : gram per hector

g kg^{-1} : gram per kilogram

ha : hectare(s)

Har. : Harvest

i.e. : That is

K : Potassium

kg : kilogram

kg ha^{-1} : Killogram per hector

m : meter

M.O.P : Muriate of potash

M.S. : Maharashtra State

M.T. : Metric tonnes

Mg : Magnesium, mega gram

mg : milligram

mg kg^{-1} : Milligram per kilogram

ml : milliliter

Mn : Manganese

N : nitrogen, North

N.S. : Non-significant

no. : Number

NUE : nitrogen use efficiency

P : phosphorus

P.D. : Particle Density

$Plant^{-1}$	: per plant
PM	: poultry manure
ppm	: parts per millions
q	: quintal(s)
q ha^{-1}	: quintal per hector
RDF	: recommended dose of fertilizer
S	: sulphur
S. E.	: Standard error
S.E. (m)	: Standard error of mean
S.S.P.	: Single super phosphate
t	: tonnes(s)
Tr.	: Treatment
var.	: Variety
viz.	: Namely
Zn	: Zinc

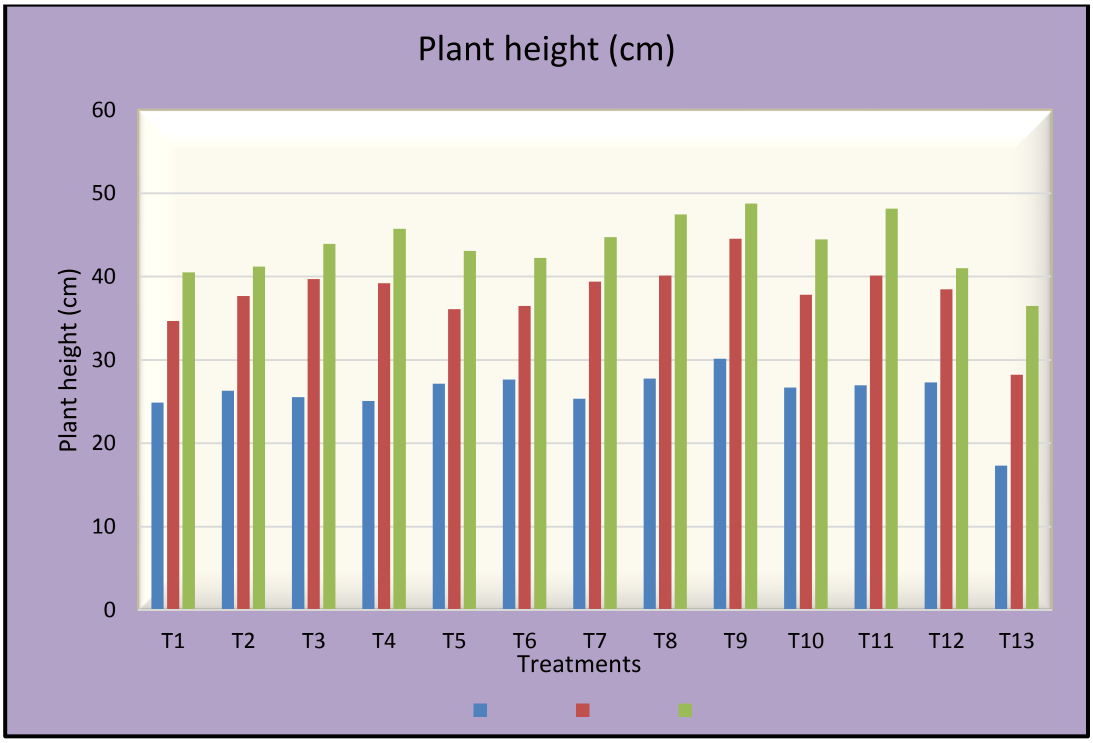


Fig-2 Effect of different sources organic manures and their combination on plant height (cm) of chilli.

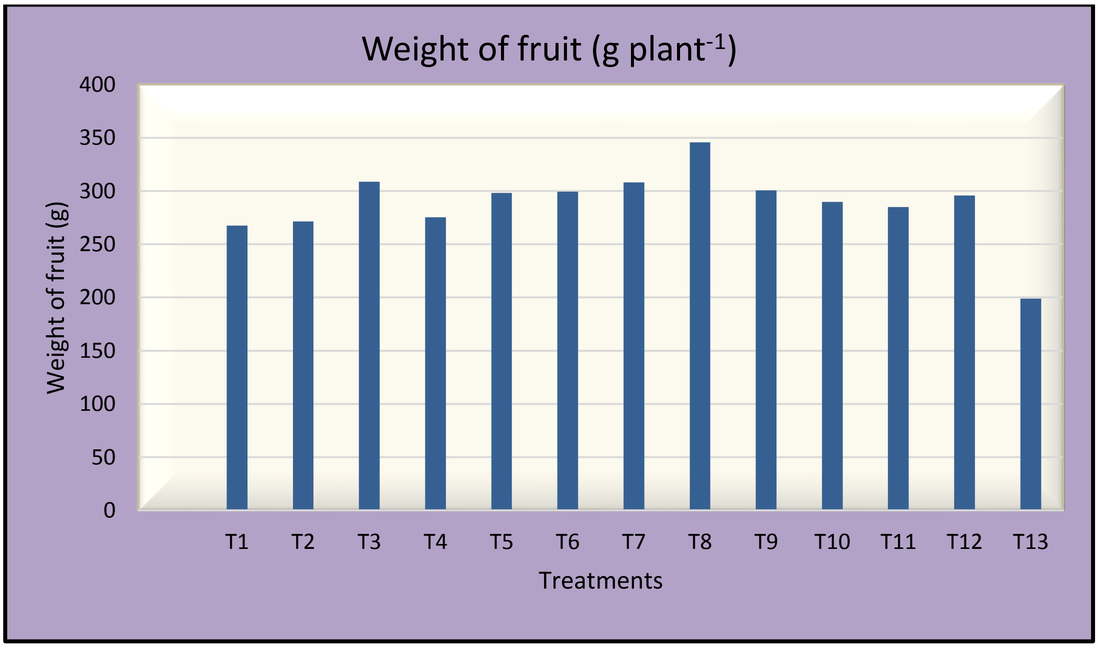


Fig- 3 Effect of different sources organic manures and their combination on weight of fruit (g plant^{-1})

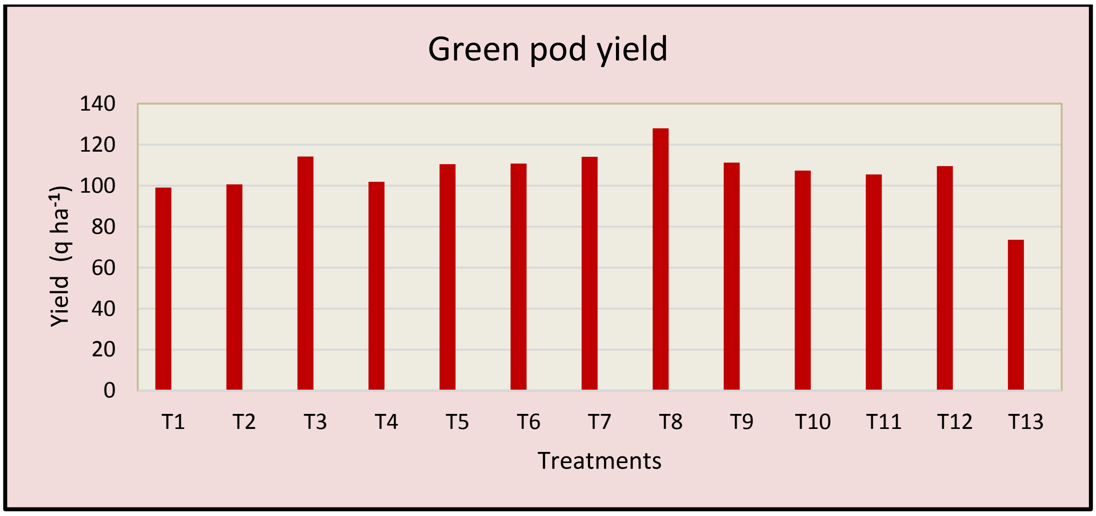


Fig- 2 Effect of different sources of organic manures and their combination on green pod yield (q ha^{-1})

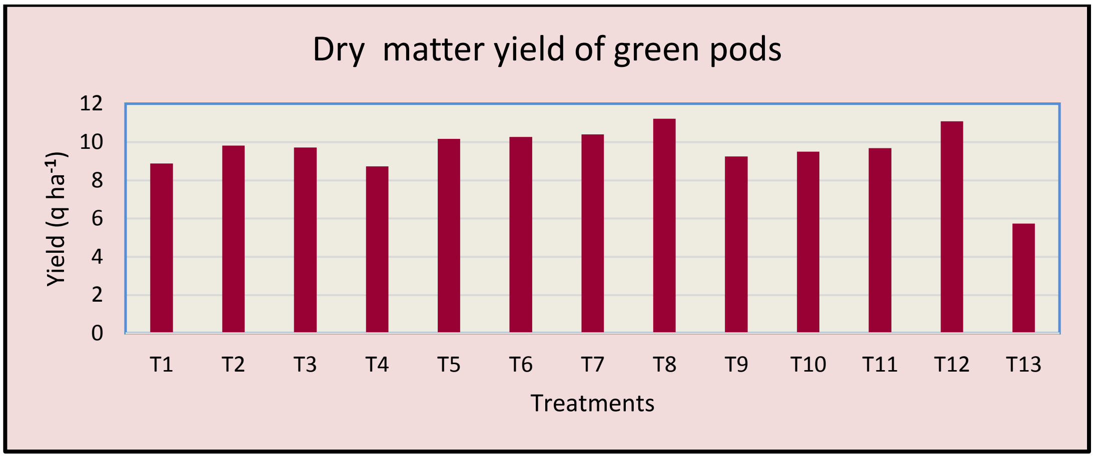


Fig. 3 Effect of different sources organic manures and their combination on Dry matter yield of green pods (q ha^{-1}).

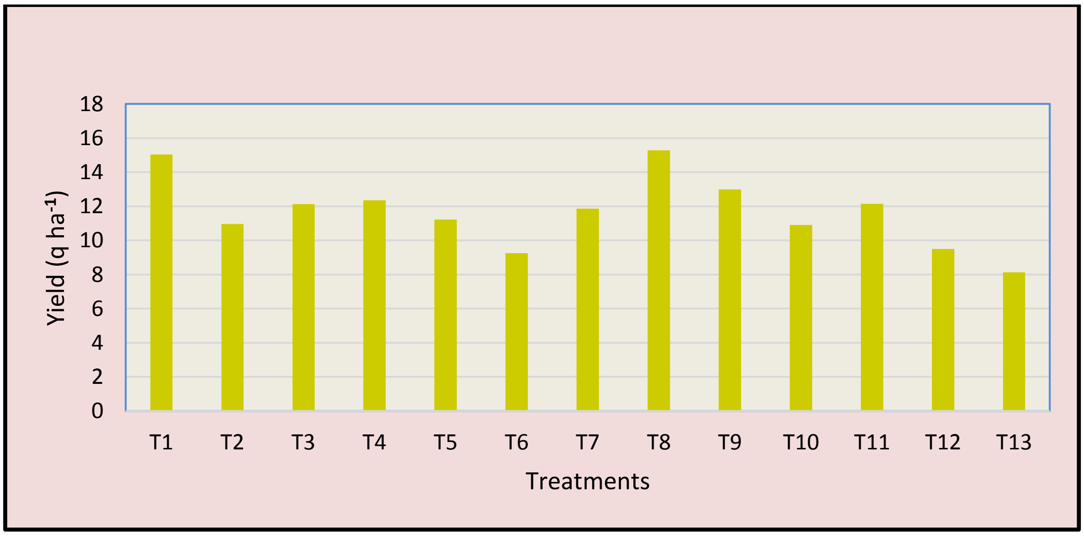


Fig- 4 Effect of different sources of organic manures and their combination on stover yield (q ha^{-1})

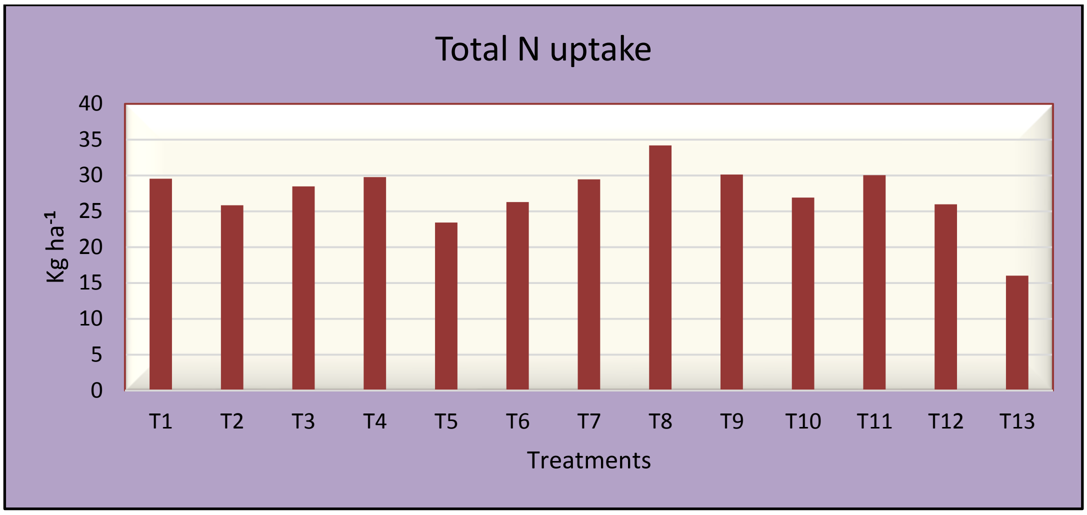


Fig- 5 Effect of different sources of organic manures and their combination on total uptake of nitrogen (Kg ha^{-1})

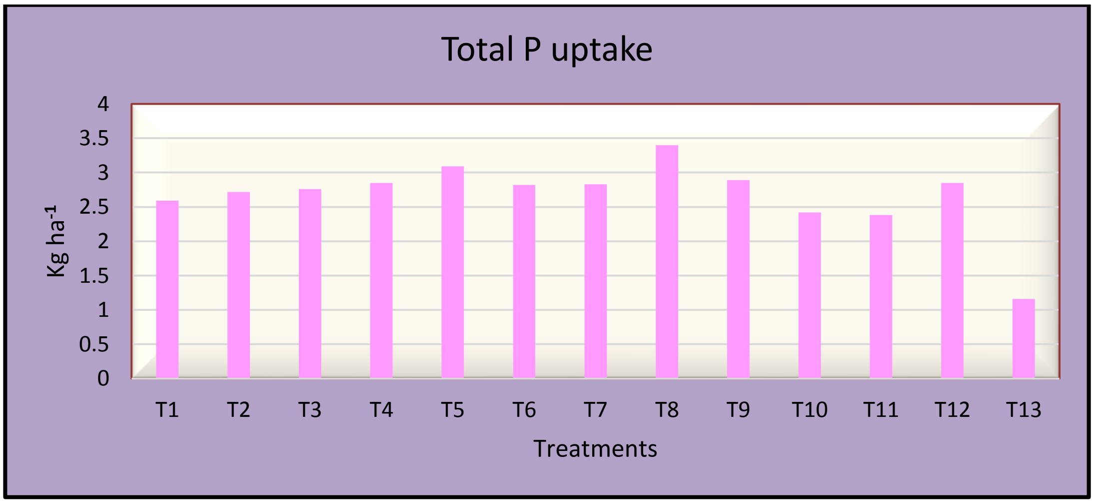


Fig- 6 Effect of different sources of organic manures and their combination on total uptake of phosphorus (Kg ha^{-1}).

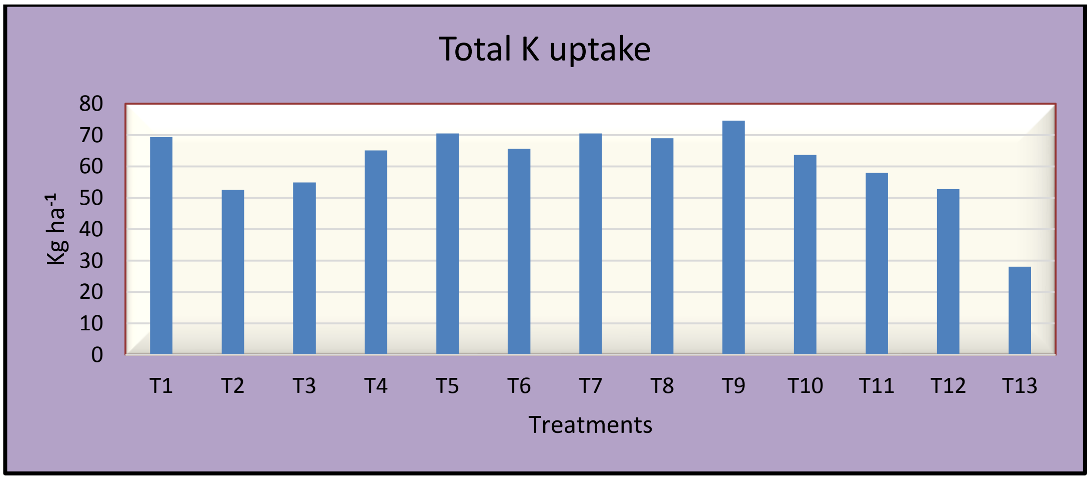


Fig- 7 Effect of different sources of organic manures and their combination on total uptake of potassium (Kg ha^{-1})

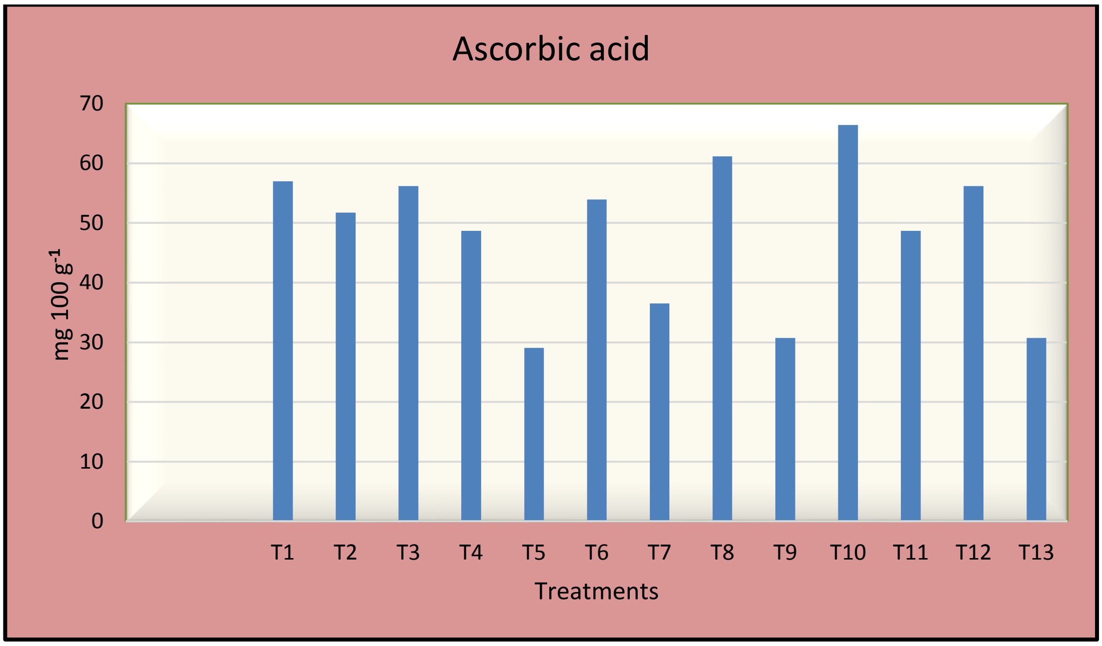


Fig- 8 Effect of different sources of organic manures and their combination on ascorbic acid content.

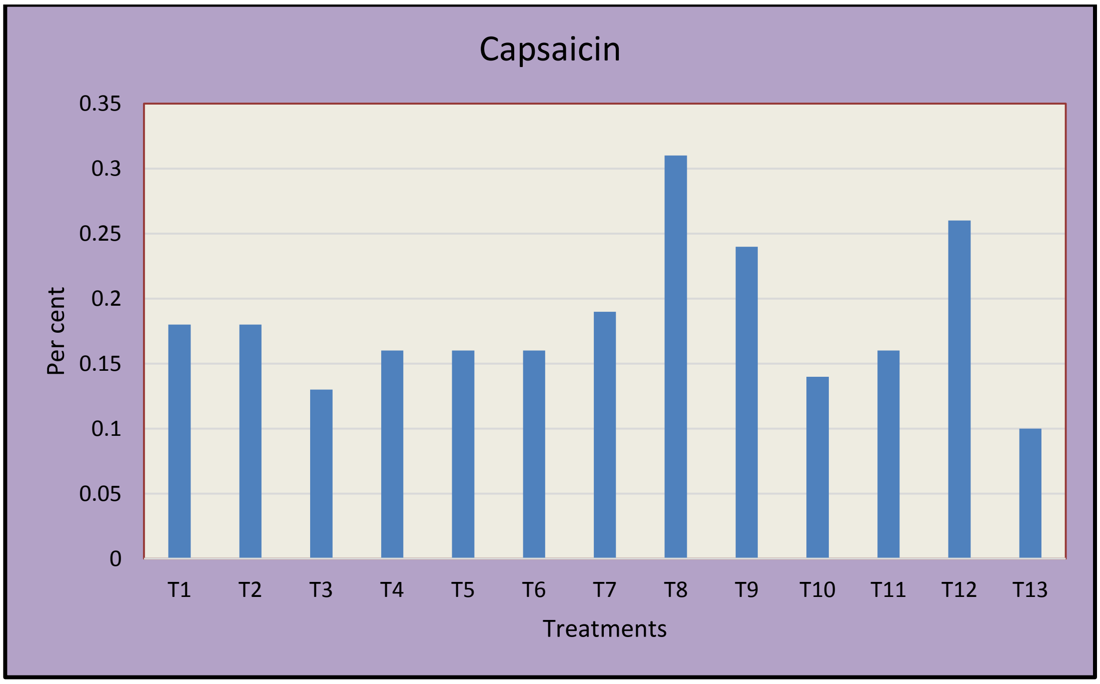


Fig- 9 Effect of different sources of organic manures and their combination on capsaicin content.

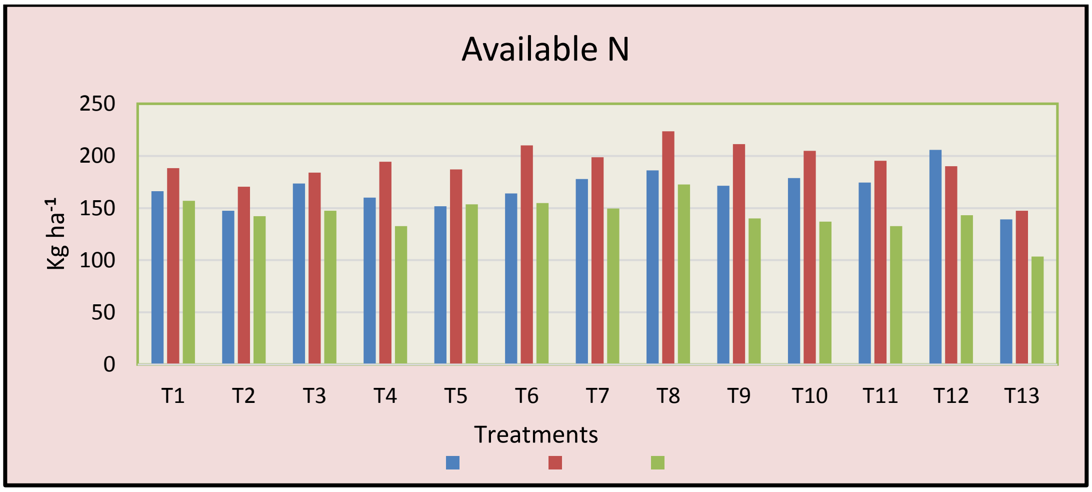


Fig- 10 Effect of different sources of organic manures and their combination on Available nitrogen content.

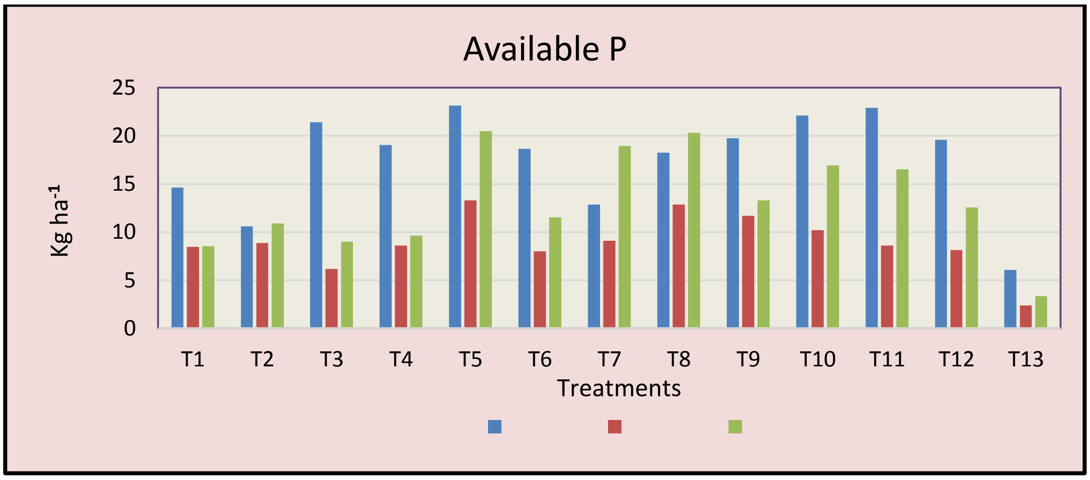


Fig- 11 Effect of different sources of organic manures and their combination on Available phosphorus content.

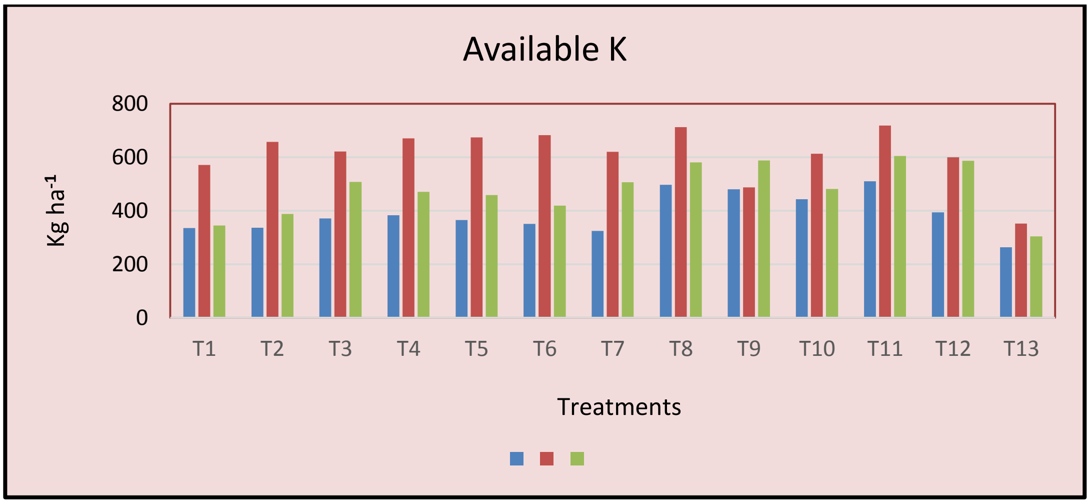


Fig- 12 Effect of different sources of organic manures and their combination on Available potassium content.

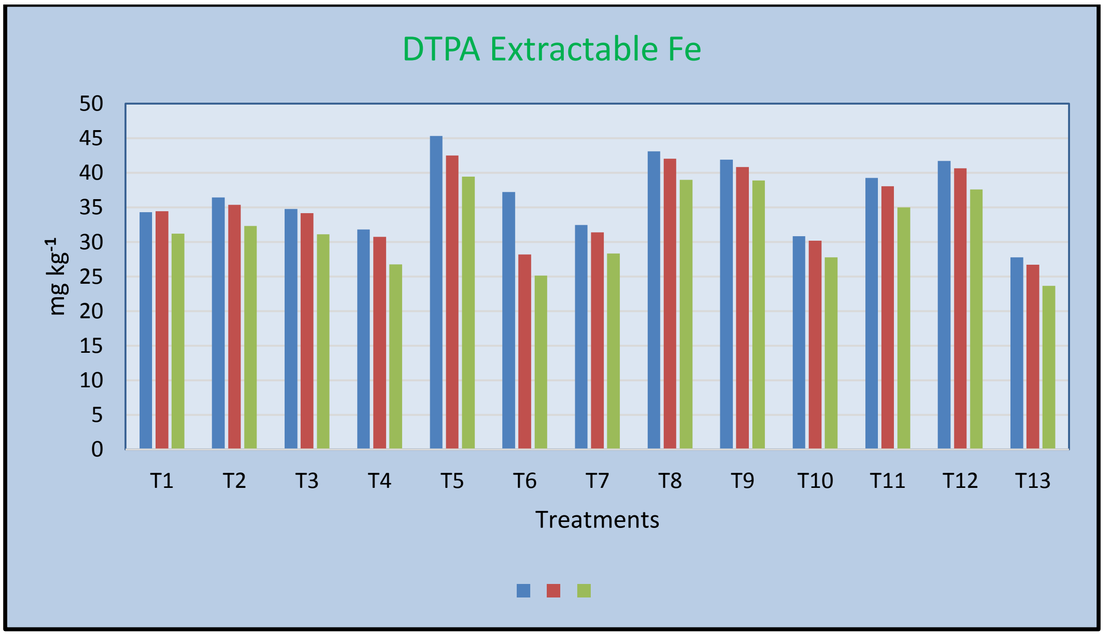


Fig- 13 Effect of different sources of organic manures and their combination on DTPA extractable Fe.

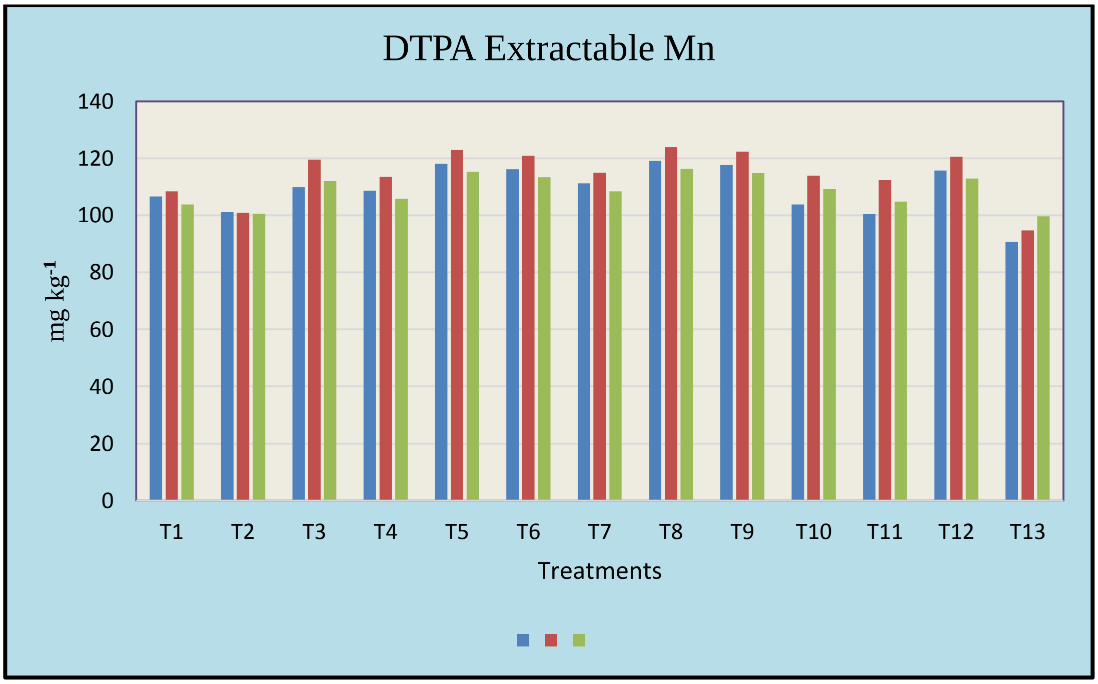


Fig- 14 Effect of different sources of organic manures and their combination on DTPA extractable Mn.

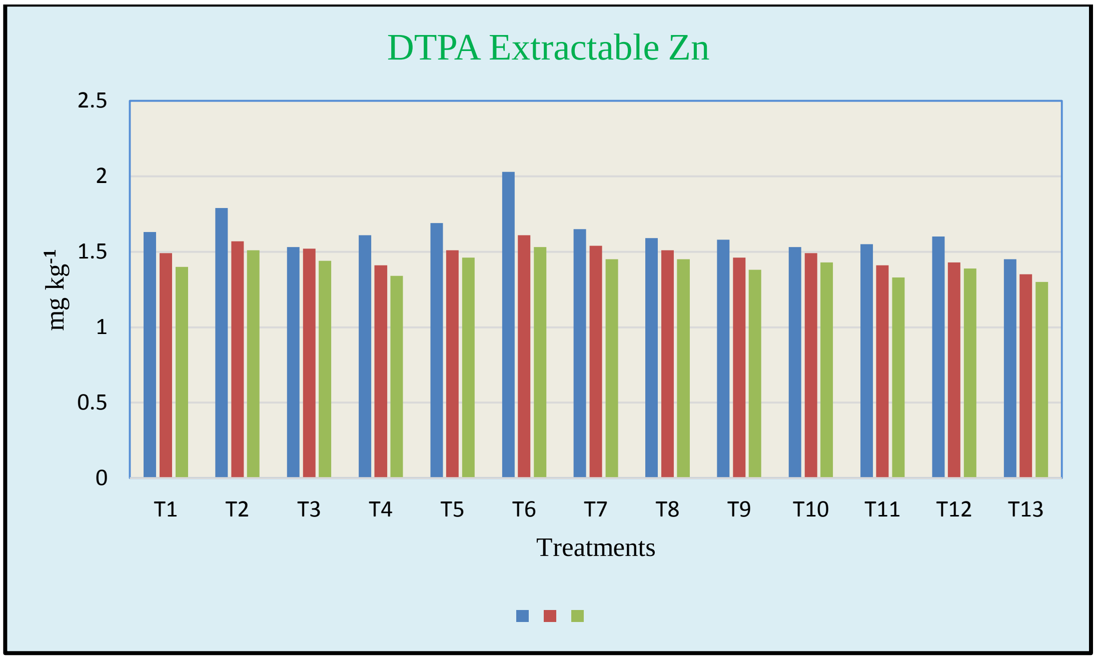


Fig- 15 Effect of different sources of organic manures and their combination on DTPA Extractable Zn

.

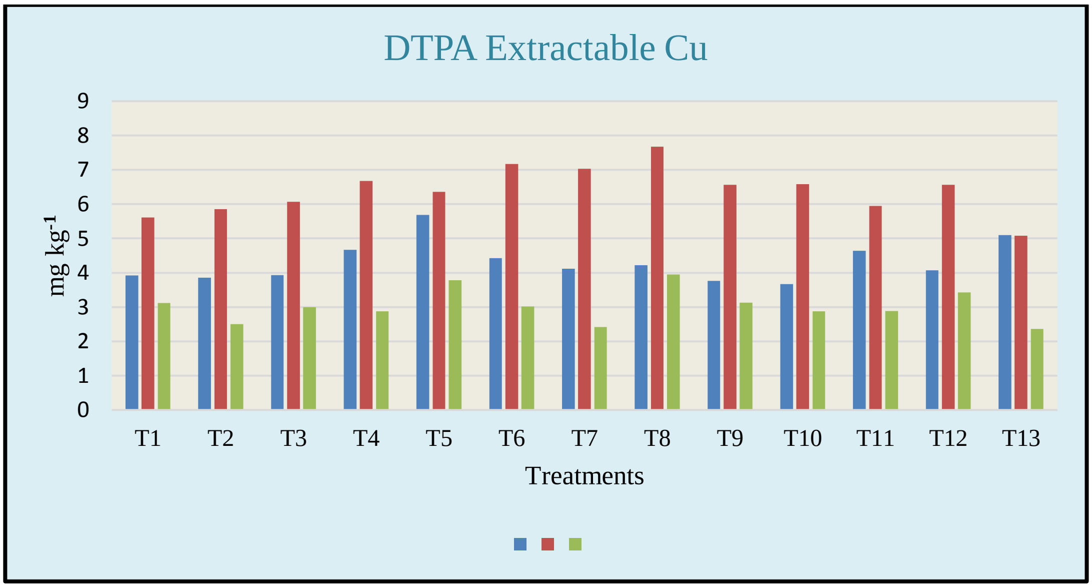
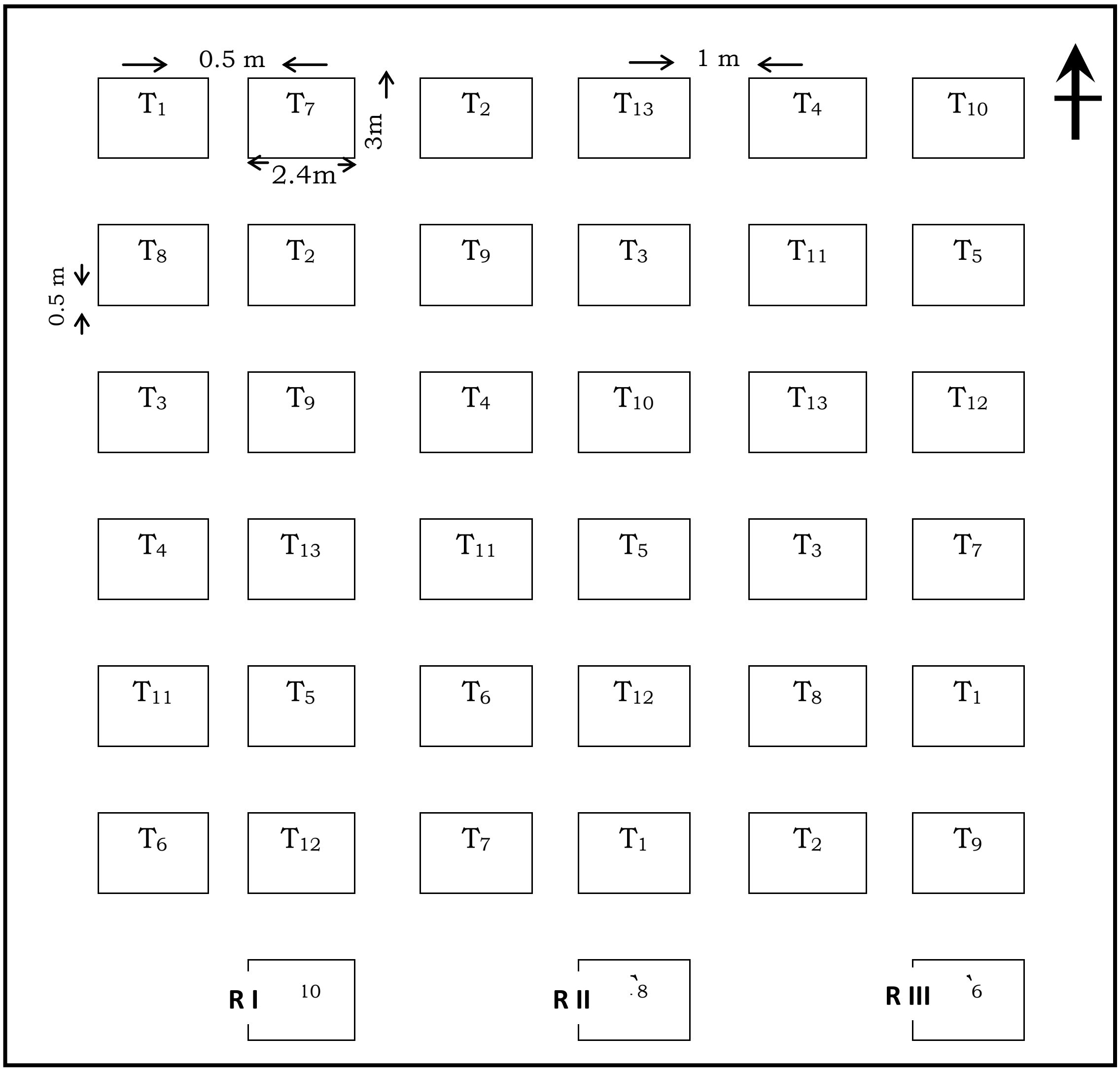


Fig- 16 Effect of different sources of organic manures and their combination on DTPA Extractable Copper.

.



1) **Crop : Chilli (Konkan Kirti)**
2) **Season : *Rabi*, 2015**
3) **Design : Randomized block design**
4) **Treatments : 13 (Thirteen)**
5) **Replication : 3 (Three)**
6) **Plot size : 3 m x 2.4 m**

Fig. 1 Layout of Field Experiment