

**STUDIES ON FERTILIZER USE ECONOMY FOR  
MAIZE CROP THROUGH VERMICOMPOST**

*by*

**MISS. SHITAL JAYSING PATIL**

**(Reg. No.01227)**

*A thesis submitted to the*

**MAHATMA PHULE KRISHI VIDYAPEETH,  
RAHURI- 413 722, DIST. AHMEDNAGAR,  
MAHARASHTRA STATE (INDIA)**

*in partial fulfillment of the requirements for the degree  
of*

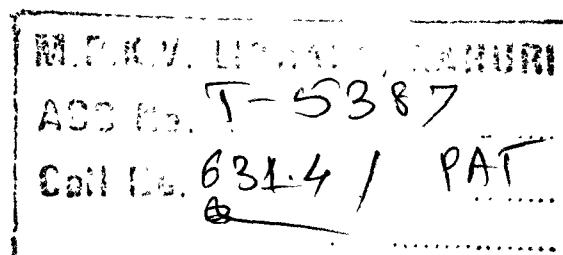
**MASTER OF SCIENCE (AGRICULTURE)**

*in*

**SOIL SCIENCE**

**Department of Agricultural Chemistry and Soil Science,  
College of Agriculture, Pune-411005**

**2003**



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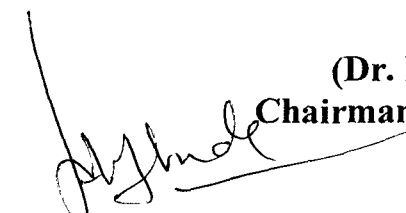
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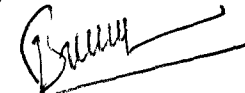


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Committee member**

**Department of Agricultural Chemistry and Soil Science,  
College of Agriculture, Pune-411005**

**2003**

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**CANDIDATE'S DECLARATION**

I hereby declare that the thesis entitled “**STUDIES ON FERTILIZER USE ECONOMY FOR MAIZE CROP THROUGH VERMICOMPOST**” or part thereof has not been submitted by me or any other person to any other University or Institute for a Degree or Diploma.

**Place: Pune**

**Dated: 3 / 07 / 2003**



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### **CERTIFICATE**

This is to certify that the thesis entitled “**STUDIES ON FERTILIZER USE ECONOMY FOR MAIZE CROP THROUGH VERMICOMPOST**” submitted to the Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE) IN SOIL SCIENCE**, embodies the results of a *bona fide* research carried out by **MISS SHITAL JAYSING PATIL**, under my guidance and supervision and that no part of the thesis has been submitted for any other Degree or Diploma.

The assistance and help rendered during the course of this investigation have been duly acknowledged.

**Place:** Agricultural College, Pune-5

**Dated:** 3 / 07 / 2003

  
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### **CERTIFICATE**

This is to certify that the thesis entitled, “ **STUDIES ON FERTILIZER USE ECONOMY FOR MAIZE CROP THROUGH VERMICOMPOST**”, submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE) IN SOIL SCIENCE**, embodies the results of a bonafide research work carried out by **MISS SHITAL JAYSING PATIL**, under the guidance and supervision of **Prof. Dr. BHIDAS P. PATIL**, Associate Professor, Agricultural Chemistry and Soil Science, College of Agriculture, Pune -5 and that no part of the thesis has been submitted for any other degree, diploma or publication in any other form.

**Place:** Agricultural College Pune-5

**Dated:** / / 2003

  
**(Dr. D. L. Sale)**  
Associate Dean

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Place : College of Agriculture, Pune-5.

Date : 3 / 07 / 2003



(Miss Shital J. Patil)

## **CONTENTS**

<b>CANDIDATE'S DECLARATION</b>	<b>II</b>
<b>CERTIFICATES</b>	
i) Research Guide	<b>III</b>
ii) Associate Dean	<b>IV</b>
<b>ACKNOWLEDGEMENT</b>	<b>V</b>
<b>LIST OF TABLES</b>	<b>VII</b>
<b>LIST OF ABBREVIATIONS</b>	<b>VIII</b>
<b>ABSTRACT</b>	<b>X</b>
<b>1. INTRODUCTION</b>	<b>1</b>
<b>2. REVIEW OF LITERATURE</b>	<b>5</b>
<b>3. MATERIALS AND METHODS</b>	<b>19</b>
<b>4. RESULTS AND DISCUSSION</b>	<b>26</b>
<b>5. SUMMARY AND CONCLUSION</b>	<b>43</b>
<b>6. LITERATURE CITED</b>	<b>47</b>
<b>7. VITA</b>	<b>56</b>

## LIST OF TABLES

<u>Table</u>	<u>Caption</u>	<u>Page</u>
1.	Chemical composition of vermicompost	21
2.	Quantity of fertilizers applied (g pot <sup>-1</sup> )	21
3.	Initial soil analysis	23
4.	Analytical methods used for soil and plant analysis	25
5.	Changes in chemical properties during vermicomposting of soybean substrate	27
6.	Effect of integrated use of inorganic fertilizers and vermicompost on the dry matter yield of maize crop at tasseling and harvesting stage	29
7.	Effect of integrated use of inorganic fertilizers and vermicompost on the uptake macronutrients by maize crop at tasseling stage	31
8.	Effect of integrated use of inorganic fertilizers and vermicompost on the uptake micronutrients by maize crop at tasseling stage	33
9.	Effect of integrated use of inorganic fertilizers and vermicompost on the uptake macronutrients by maize crop at harvesting stage	35
10.	Effect of integrated use of inorganic fertilizers and vermicompost on the uptake micronutrients by maize crop at harvesting stage	37
11.	Effect of integrated use of inorganic fertilizers and vermicompost on the pH, EC and organic carbon content of soil after the harvest of maize crop	38
12.	Effect of integrated use of inorganic fertilizers and vermicompost on the macronutrients of soil after the harvest of maize crop	40
13.	Effect of integrated use of inorganic fertilizers and vermicompost on the micronutrients of soil after the harvest of maize crop	42

## ABBREVIATIONS

@	At the rate of
Agric	Agriculture
C	Carbon
CD	Critical Difference
$^{\circ}\text{C}$	degree centigrade
Ca	Calcium
Cu	Copper
Conc.	Concentration
$\text{dS m}^{-1}$	deci Siemens per meter
DTPA	Diethyl Triamine Penta Acetic Acid
EC	Electrical Conductivity
et al.	et alibi (and others)
Fe	Iron
Fig.	Figure
g	gram (s)
ha	hectare
i.e.	id est (that is)
INM	Integrated Nutrient Management
K	Potassium
$\text{K}_2\text{O}$	Potash (Potassium Oxide)
Kg	Kilogram (s)
L	Litre

m	meter (s)
mg	milligram
Mn	Manganese
N	Nitrogen
No.	Number
NS	Non-Significant
P	Phosphorus
pH	Pussance de hydrogen
P <sub>2</sub> O <sub>5</sub>	Phosphorus Pentaoxide
ppm	Parts per million
q ha <sup>-1</sup>	Quintal per hectare
RDF	Recommended dose of fertilizers
SE	Standard Error
t	tonne
VC	Vermicompost
Viz.	Videlicent (namely)
Zn	Zinc

**ABSTRACT****STUDIES ON FERTILIZER USE ECONOMY FOR MAIZE CROP  
THROUGH VERMICOMPOST***by***MISS SHITAL PATIL**

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A pot culture experiment entitled, "**Studies on fertilizer use economy for maize crop through vermicompost**" was conducted at College of Agriculture, Pune-5 in randomised block design during the year 2002-2003 in monsoon season. The pot culture experiment comprising 20, 40, 60, 80 and 100 per cent recommended dose of N in combination with vermicompost @

20, 15, 10, 05 and 0 t ha<sup>-1</sup> alongwith one control without inorganic fertilizers and vermicompost.

Firstly vermicompost was prepared from soybean waste to study the chemical changes during the process of vermicomposting. Vermicompost prepared was neutral in reaction . Marked decrease was recorded in the C/N ratio of soybean waste. The N, P and K content of substrate also increased spectacularly during the process of vermicomposting.

Results of pot culture study revealed that vermicompost application with reduced dose of recommended fertilizers had a positive effect on uptake of nutrients by maize crop at tasseling as well as harvesting stage. The dry matter yield of crop was higher in treatments receiving vermicompost application in conjunction with inorganic fertilizers than control and application through inorganic fertilizers only. Treatment with 60 percent recommended dose of nitrogen fertilizers and vermicompost @ 10 t ha<sup>-1</sup> increased the uptake of N, P and K nutrients significantly. Micronutrient uptake also increased in the similar treatment than all other treatments under studies.

Soil analysis after the harvest of crop showed the effect of vermicompost application on the soil fertility. Soil analysis results showed that the organic carbon content of soil increased significantly by vermicompost application. When vermicompost applied @ 10 t ha<sup>-1</sup> with 60 percent recommended dose of nitrogen through chemical fertilizers, the available nitrogen, phosphorus and potassium content of soil increased

significantly. DTPA extractable micronutrient (Fe, Mn, Zn and Cu) concentration was higher in the same treatment than other treatments.

The vermicomposting process increased utility of waste material by enriching initial substrate. Nutrient value of the waste could be improved by the process of vermicomposting. Integrated use of inorganic fertilizers with vermicompost was found beneficial. Reduced recommended dose of fertilizers alongwith vermicompost application recorded promising results than farmer's practice and use of chemical fertilizers only. Vermicompost application not only increased uptake of nutrients by the crop but also maintained the soil fertility for macro and micronutrients.



# INTRODUCTION

## I. INTRODUCTION

From the ancient time the people are trying for better crop cultivation through soil fertility management. One of the milestones in the area was the discovery of superphosphate in 1840 by John Bennet Lowes. With this discovery use of chemicals for crop growth started.

The population of developing countries has been growing rapidly and the demand for the food has always been able to keep up with population growth. The “Green revolution” was put ahead, through which high yielding varieties (HYVs) were introduced. In past 40-50 years cereal production have doubled and have kept pace with need to feed rising population. The high yielding varieties need a higher dose of nutrients and to fulfil it, use of chemical fertilizers was maximized. The intensive use of chemicals led to many hazardous problems to environment. Damages of green revolution came in sight during last decade like air, water and soil pollution leading to loss of genetic diversity and ecosystem disturbance with the problems like contamination of soil by heavy metals through fertilizers, deterioration of surface as well as ground water quality, soil erosion and depletion etc.

Recent years more importance has been given to sustainable crop production. This is because modern of agriculture from last several years depended heavily on use of chemical fertilizers, which are mostly cost intensive and have many adverse effect on soil fertility beside environmental problems. Therefore, the need of hour is to popularise the eco friendly and cost effective organic manures and bio-fertilizers.

Many alternatives are available for chemical agriculture to avoid their adverse effect.

Organic farming deals with use of organic material for the cultivation e.g. organic manures, bio-fertilizers, bio-pesticides etc. In sustainable agriculture use of chemicals is decreased up to certain level accompanied with the increased doses of organic material. Term eco-farming or ecological farming implies that the farming regions and individual farms must be treated as ecosystem and farming is based on relationship among the organisms and their environment in ecosystem.

Integrated nutrient management (INM) is a flexible approach to minimize the use of chemicals. Practising INM can bridge the gap between nutrient removal and addition. The components of INM i.e. intensified cropping, vermicompost, green manuring and bio-fertilizer with chemical fertilizers can help for better crop production. The supplementary and complementary use of organic manures is known to improve physico-chemical properties of soil and prevents micronutrient deficiencies and thereby improves the yields.

The recycling of organic waste for increasing soil fertility has gained importance in recent years due to high cost of fertilizers and reduced availability of organic manures. A wide variety of wastes are being generated which are known to contain appreciable amount of organic matter and plant nutrient elements and can be effectively used as source of organic manure. It improves humus content of soil to enhance microbiological activities and improves soil physical properties (Singh and Vivek-kumar 2000).

It has become necessary to use organic manures to recoup the soil health, which has deteriorated due to indiscriminate use of chemical fertilizers over the years.

Charles Darwin (1881) was the first who draw attention to importance of earthworms in his book “The formation of vegetative mould through action of worms”. After him, many scientists worked on the earthworms and their utility in soil management. It is known to all that earthworms plays an important role in soil fertility management (Ismail and Thampan 1995).

Vermicompost refers to organic manure produced by earthworms. It is a mixture of worm casting, their cocoons and other organisms. Vermicastings are a rich source of macro and micronutrients, vitamins, antibiotics, growth harmones and immobilised enzymes like protease, lipase, amylase, cellulase, lichenase, and chitinase which keep on their function of biodegradation of macromolecules of the agricultural residues in soil and other microflora (Kale 1994, and Purohit 2003). The vermicompost prepared from different earthworm species and different organic wastes has different nutrient composition (Shinde et al. 1992). It has been also proved that vermicompost application is effective against some pests and can be used as a bio-pesticide (Ramesh 2000). Vermitechnology is combination of vermiculture and vermicomposting for development of aerable soils, breakdown of waste material, production of useful products like vermicompost and maintaining environment quality and soil fertility.

Enough information is available on vermicomposting in laboratory and semi-natural conditions however very few attempts

have been made to degrade the organic matter waste on large scale under open field conditions, so as to produce vermicompost in large quantities and also on fertilizer economy through use of vermicompost for cereal crops. *With these points in mind, investigation was undertaken to study the fertilizer use economy and the effect of integrated use of vermicompost in combination with inorganic fertilizers on uptake of nutrients by maize crop in pot culture with the following objects:*

1. To study the chemical changes during decomposition of agricultural waste material in association with earthworms.
2. To study the effect of vermicompost in combination with inorganic fertilizers on nutrient availability.
3. To study the effect of vermicompost on uptake of nutrients by maize crop.

REVIEW OF  
LITERATURE

## II REVIEW OF LITERATURE

This chapter deals with review of research work done by various scientists on the compost and vermicompost and its effect on soil and crop growth. Since, vermicomposting is recently introduced in Indian farming, the information available on its effect on soil properties is meagre. An attempt is made to present the available literature under the following heads.

- 2.1 Effect of vermicompost and organic manures in conjunction with inorganic fertilizers on nutrient availability.**
  - 2.2 Chemical changes during vermicomposting.**
  - 2.3 Chemical properties of vermicompost.**
  - 2.4 Effect of vermicompost on properties of soil.**
  - 2.5 Effect of vermicompost on availability of nitrogen.**
  - 2.6 Effect of vermicompost on yield of crops.**
  - 2.7 Effect of vermicompost on uptake nutrients by maize crops.**
- 
- 2.1. Effect of vermicompost and organic manures in conjunction with inorganic fertilizers on nutrient availability :**

Joseph et al. (1952) reported that organic matter added in soil as an amendment increased phosphorus availability as easily decomposable

organic matter was more effective than organic substances, which decomposed slowly. The addition of oxidisable materials in soil increased the reduction process and thereby increased  $P_2O_5$  availability in soil. Sen Kolodziej and Kostecka (1994) observed that the application of FYM with the inorganic fertilizers increased the dry matter yield as well as grain yield of maize crop, which was again confirmed by Biswas et al.(1971). Tiwari et al. (1980) reported that dhaincha as green manure increased availability of potassium in soil and also yield of rice.

Tiwari et al. (1980) stated that green manuring with leguminous crops had positive influence on K availability of soils. An experiment conducted by Balasaraf (1990) showed that the application of FYM, PMC and iron pyrite significantly increased the plant height, number of leaves, weight of cobs and dry matter yield of maize crop.

Patil (1993) studied the effect of application of vermicompost and FYM on release of nutrients and their uptake and yield by maize in different textured soil. Their studies revealed that application of FYM and vermicompost resulted into significant increased the availability of N, P and K in clay soil than in clay loam and sandy soils. Application of vermicompost significantly improved the physical properties of all the soil types under study. Application of FYM and vermicompost resulted into significant increase in electrical conductivity, organic carbon, available N, P and K contents of all the soil types, whereas pH of all soil types significantly decreased. Vermicompost application showed the significant improvement in chemical properties of soil. Application of vermicompost @  $5 \text{ t ha}^{-1}$  significantly increased total N, available N, P and K and organic carbon, porosity of soil and decreased bulk density over control (Hapse et al. 1993).

Studies of Rao and D'akore (1993) showed the effect of compost and vermicompost on soil properties and biomass production in maize. The vermicompost had narrower C:N ratio compared to compost. Vermicompost was found superior over compost as it released available nutrients in soil since it contained higher amount of N, P, K, Ca, Mg, S and micronutrients as compared to compost.

Malarvizhi and Faziullah Khan (1999) studied effect of organic sources viz. vermicompost, FYM, sewage sludge conjointly with four levels of nitrogen viz. 0, 30, 60 and 90 kg ha<sup>-1</sup> on yield and quality of fodder sorghum (Co.27). results revealed that green as well as dry weight of crop increased significantly by the application vermicompost @ 10 t ha<sup>-1</sup> with nitrogen

60 kg ha<sup>-1</sup>. Mishra and Das (2000) observed that in acid sandy loam soil when (Al saturation of 35 per cent) fertilized with either soluble, insoluble or partly soluble phosphorus sources, amended with FYM, cowpea, dhaincha, paddy straw or lime and incubated for 75 days, the decomposition of organic residues was maximum between 30 to 45 days. After 45 days, available P in soil increased and increase was more in organic than lime amended soil.

## 2.2 Chemical changes during vermicomposting:

Riffaldo and Levminzi (1982) concluded from their experiment on earthworms *Eisenia foetida* that high humification rate of castings was responsible for the decrease in the C/N ratio of the organic matter in vermicomposting process. Albanell <sup>et al.</sup> (1988) analysed the casting of *Eisenia foetida* from sheep waste alone and mixed with cotton waste for their chemical composition for every weeks. Both types of vermicompost

showed lower pH, greater CEC, concentration of soluble salts, organic matter, N and higher concentrations of total humic acids and mineral nutrients. The vermicomposts were enriched in N, P, K and Na than the original raw organic material. He concluded that the earthworms accelerated rate of mineralization and degree of humification and converted the manures into castings with a higher nutritional value. Increase in organic carbon enables slow release of nutrients Jambhekar (1990).

Gunathilagaraj and Ravignanan (1996) observed increased N, P and K content with Cu, Mn, Zn and Fe content of vermicompost prepared from sericulture waste. Hangarge and his associates (1998) conducted an experiment at department of Agricultural Chemistry and Soil Science, MAU, Parbhani to compare the vermicomposts prepared from various agricultural wastes. They studied the chemical changes during the process of vermicomposting for parameters like organic carbon, C:N ratio, NPK status and microbial count. Experiment results revealed that organic carbon ranged from 28.24 to 14.18 per cent during experimentation while C:N ratio range was 12.54 : 1 to 9.04 : 1 at the end.

### **2.3. Chemical properties of vermicompost :**

Inoculation of manures by *Eisenia foetida* earthworms increased the rate of humification and decomposition than the uninoculated manures (Riffaldo and Levminzi, 1982). Sharma and Madan (1983) observed that earthworm castings contain about 5 times more nitrate nitrogen, 14 times more calcium, 3 times more magnesium and 11 times more potassium than that of 6 inches top soil. The chemical composition of worm cast of *Eudrilus eugineae* spp. of earthworms was studied by Talashilkar et al.(1999) and reported that it had neutral pH 7.1. Electrical

conductivity of worm cast was  $1 \text{ dS m}^{-1}$ . Organic carbon, nitrogen, phosphorus and potassium content of worm cast was 4.6, 0.5, 1.2 and 0.1 per cent respectively.

Albanell et al. (1988) concluded that earthworms accelerated mineralization rate with higher degree of humification in case of sheep manure and cotton waste. Shinde et al. (1992) reported that vermicompost contains more carbon and phosphorus than FYM, it had less K and micronutrients than FYM and both had comparable nitrogen contents. Vermicompost generally had narrow C:N ratio as compared to FYM. During process of decomposition of organic matter, organic acids produced in transformation cycles and action of microbes contributed to solubilize the nutrients from soil or parent material (Sarkar et al. 1998).

Kale (1998) studied on biodegradable organic waste for preparation of vermicompost. Waste undergoes physical and chemical breakdown during processes of ingestion and digestion, when earthworms feed on it. About 5-10 per cent of the ingested material was absorbed into the tissue for their growth and metabolic activity and rest was excreted as cast. The cast was mixed with mucus secretion of gut wall and of the microbes. These add to structural stability of the cast, which was used as vermicompost.

An experiment conducted for two consecutive years, during kharif and rabi seasons of 1994-95 and 1995-96 at Hyderabad (Reddy and Reddy, 1999) on sandy loam soil with maize (DHM-105) in kharif and soybean in rabi season with four levels i.e. 0, 25, 75 and 100 per cent substitution of recommended dose of nitrogen by vermicompost, poultry manure, biogas slurry and FYM. They analysed nutrient content of organic manures and gave chemical composition of vermicompost. Vermicompost

contains 1.98 per cent N, 1.23 per cent P, and 1.59 per cent K, total and DTPA extractable micronutrients status were also given as total Zn 132.0 mg kg<sup>-1</sup>, Cu 70.5 mg kg<sup>-1</sup>, Fe 1440.2 mg kg<sup>-1</sup>, and Mn 317.5 mg kg<sup>-1</sup>. Talashikar et al. (1999) studied nutrient composition and humus fractions of an ordinary compost and vermicompost prepared from organic residues like local grass, mango leaves and farm waste using *Eisenia foetida* species of earthworms. Vermicomposting of local grass, mango leaves and farm wastes increased in total nitrogen content by 0.16 per cent, 0.07 per cent and 0.03 per cent over the composting of said residues without earthworms. While that of total phosphorus content increased by 0.01 per cent and 0.07 per cent for local grass and mango leaves, respectively. Similarly inoculation of earthworms exhibited considerable increase in humic acid content by 0.32 per cent, 0.30 per cent and 0.25 per cent of local grass, mango leaves and farm wastes, respectively over the uninoculated residues.

Kachhave and Jaishankar (1999) tried to identify the best organic waste for vermicomposting by conducting experiment with saw dust, city waste, sugarcane trash, weed plant (*Parthenium* spp.), pressmud and slaughter house waste under composting, pit and pot methods. The highest enhancement of 1.22 per cent N was recorded for slaughterhouse waste and least with cane trash. The maximum levels of P and K were recorded for pressmud vermicompost and least enhancement for saw dust vermicompost. The wider C:N ratio was obtained for vermicompost prepared from cane trash while narrowest C:N ratio were found to slaughterhouse waste followed by city waste vermicompost.

Efficacy of vermicompost prepared from different organic materials like sugarcane trash, ipomea weed, neem leaves, parthenium weed and banana waste was evaluated by Vasanthi and Kumaraswamy, (1999) in a

field experiments during 1994-95 and 1995-96 on red sandy clay loam soil at College of Agriculture, Madurai. The data on nutrient status showed that contents of macro and micronutrients were more by many times in composted materials as compared to contents in raw material. Nitrogen content in vermicompost prepared from organic wastes was in the tune of ipomea weed (2.99 per cent) > banana waste (2.83 per cent) > parthenium weed (2.99 per cent) > sugarcane trash (2.67 per cent) > neem leaves (2.61 per cent). Similarly, per centage phosphorus content in vermicompost prepared from organic wastes followed the order ipomea weed (1.37 per cent) > parthenium weed (1.20 per cent) > banana waste (1.18 per cent) > neem leaves (1.17 per cent) > sugarcane trash (1.06 per cent). The potassium content of vermicompost was in the order of : ipomea weed (1.46 per cent) > banana waste (1.32 per cent) > parthenium weed (1.19 per cent) > neem leaves (1.03 per cent) > sugarcane trash (1.00 per cent). Similarly, there was appreciable increase in Ca, Mg, Fe, Mn, Zn and Cu content of vermicompost as compared to raw organic waste.

#### **2.4. Effect of vermicompost on properties of soil :**

Datta (1948) observed that the earthworm activities in soil increased the amount of water stable aggregates. Hapse et al. (1993) observed that application of vermicompost @ 5 t ha<sup>-1</sup> significantly decreased the bulk density and increased the porosity of soil as compared to control. Earthworms supplied through vermicompost could have tilled the soil, making it congenial for extensive root remification and also contain more number of various beneficial micro-organisms for better plant growth (Bhawalkar and Bhawalkar 1992).

Patil (1993) studied the effect of application of vermicompost and FYM on release of nutrients and their uptake and yield by maize in different textured soil. Studies revealed that application of FYM and vermicompost resulted into significant increase in electrical conductivity, organic carbon, available N, P and K contents of all the soil types, whereas pH of all soil types was more or less similar. Application of vermicompost significantly improved the physical properties of all the soil types under study. Earthworms physically mix the contents of the deeper layers and make the soils loose and porous. Their body exudates improve the water holding capacity of soil and promote establishment of micro-organisms (Kale 1994).

Damshetti (1997) found that the availability of macro and micronutrients increases in soil with application of vermicompost and FYM, which increased dry matter yield, seed yield of sunflower crop. Vasanthi and Kumarswamy (1999) observed that the bulk density of soil decreased from  $1.56 \text{ Mg m}^{-3}$  to  $1.36 \text{ Mg m}^{-3}$  by the application of vermicompost prepared from parthenium waste and applied @  $5 \text{ t ha}^{-1}$ . The pooled results showed that the application of ipomea vermicompost @  $10 \text{ t ha}^{-1}$  could increased the cation exchange capacity of soil upto  $21.7 \text{ cmol (p}^+) \text{ kg}^{-1}$  over control having CEC  $10.9 \text{ cmol (p}^+) \text{ kg}^{-1}$ . On application to different crops, it has improved the water infiltration rate and hydraulic conductivity of the soil.

## **2.5 Effect of vermicompost on availability of nitrogen :**

By testing different sources of nitrogen (urea, FYM, compost and vermicompost) for the soybean yield and quality Bachhav and Sable (1996) concluded that the application of vermicompost increased the availability of nitrogen for better crop growth. To test the efficacy of

vermicompost as a potential supplement to nitrogenous fertilizers , Rani Srivastava (1997) conducted an experiment on rice with full dose of nitrogen replaced by one third and quarter of N as vermicompost . Compared with N fertilizer alone, vermicompost application showed increased in grain yield and yield components of rice.

Reddy and Reddy (1999) conducted an experiment for two consecutive year during kharif and rabi season of 1994-95 and 1995-96 using combinations of four levels 25, 50, 75 and 100 per cent substitution of recommended dose of nitrogen by vermicompost, poultry manure, biogas slurry and FYM. In all types of manures the treatment with 100 per cent level of vermicompost which was on par with 75 and 50 per cent level of manures showed highest available nitrogen content i.e. 220.20 kg ha<sup>-1</sup> over the treatments receiving poultry manure, biogas slurry, FYM and the control treatment.

Nethra et al. (1999) in his experiment on china aster applied vermicompost (0, 5, 10, 15 t ha<sup>-1</sup>) in combination with 50 or 100 per cent recommended dose of NPK and found that availability of nitrogen can be significantly increased upto 493.31 kg ha<sup>-1</sup> with vermicompost @ 5 t ha<sup>-1</sup> along with 100 per cent NPK. It also improved the availability of phosphorus and potassium as well as micronutrients.

Vasanthi and Kumaraswamy (1999) conducted a field experiments during 1994-95 and 1995-96 on red sandy loam soil at Madurai to evaluate effect of vermicompost prepared from different organic materials to increase the soil fertility status. The pooled results of three experiments showed that available nitrogen status in the soil was significantly higher in the treatments that received vermicompost besides N, P and K. The available nitrogen status ranged between 192 kg ha<sup>-1</sup> in NPK alone treatment and 290

kg ha<sup>-1</sup> in ipomea vermicompost plus N, P and K treatment. The average available nitrogen status in the soil at 5 and 10 t ha<sup>-1</sup> of vermicompost was 242 and 239 kg ha<sup>-1</sup>, respectively. Earthworm casting activity involved increased 11.6 per cent of organic carbon and 12.9 per cent of the total nitrogen of the 0-15 cm topsoil in undisturbed or recovering systems (Sharma, 2001).

## 2.6 Effect of vermicompost on yield of crops :

Organic manures can help to increase the yield of crop. Various experiments have been conducted to evaluate the utility of vermicompost for better crop production.

Rani and Shrivastava (1997) recorded that supplying 1/3<sup>rd</sup> or 1/4<sup>th</sup> of N through vermicompost and proportionate urea increased plant height, dry matter yield, grain yield, and yield components of rice. Effect of vermicompost was compared by Tomar et al. (1998) at IARI with FYM, urea and combination of vermicompost and FYM (1:1) on brinjal and carrot. Yield of brinjal crop was highest with vermicompost (97 g per plant) than FYM (85 g per plant), urea (71.25g per plant), vermicompost + FYM in 1:1 proportion (57.5 g per plant). Similar results were also obtained in the carrot crop, which indicated that vermicompost was more effective than other organic manures. Yield of sugarcane also increased by combining the inorganic fertilizers with vermicompost (Zende <sup>et al.</sup> 1998).

Atiyesh et al. (1999) studied on potting media Metro-Mix 360, peat/perlite mixture, and coir/perlite mixture with tomato as test crop. Each media was substituted with 10, 25, 50 and 100 per cent vermicompost. A significant increase was recorded in plant height and root and shoot biomass

etc. with increased in vermicompost concentration. Tomato plant grew better in 100 per cent vermicompost than 100 per cent commercial medium. Nethra et al.(1999) conducted an experiment on the use of vermicompost as organic amendment for floricultural crops and found that best growth (tallest plants, highest number of branches and highest number leaves) and yield (34.33 flowers per plant; 6840 kg ha<sup>-1</sup>) of china aster were recorded after application of 10 t vermicompost per ha with 100 per cent NPK.

Ushakumari et al. (1999) found that vermicompost @ 12 t ha<sup>-1</sup> with full dose of inorganic fertilizers gives highest yield of okra i.e. 56.63 q ha<sup>-1</sup> followed by vermicompost @ 12 t ha<sup>-1</sup> and 3/4th NPK dose (46.80 q ha<sup>-1</sup>). Results proved better than FYM with full dose of NPK. Under the nitrogen management experiment, wheat-coriander cropping system, coriander was taken as a catch crop after wheat. Yields were found to be higher in the treatment getting half nitrogen through vermicompost and half as urea than other organic manure. Maximum growth, dry matter and green yield (25.30 q ha<sup>-1</sup>) were obtained from the residual effect of treatment getting half nitrogen through vermicompost and half as urea (Desai et al. 1999).

Integrated effect of inorganic fertilizers (0, 25, 50, 100 per cent) of RDF and vermicompost (0, 5, 10, 15 t ha<sup>-1</sup>) was examined by Sreenivas et al.(2000) at Hyderabad on ridge gourd. He found that soil available N increased with the increased levels of vermicompost. Highest yield of ridge gourd was obtained with 10 t ha<sup>-1</sup> vermicompost along with 50 per cent of recommended dose of fertilizers. Kachapur et al.(2001) replaced 1/4<sup>th</sup>, 1/2<sup>th</sup>, 3/4<sup>th</sup> and full dose of fertilizers of sorghum crop with vermicompost (0.5, 1, 1.5 t ha<sup>-1</sup>) and from it he quoted result that 0.5 t ha<sup>-1</sup>

vermicompost with 3/4<sup>th</sup> dose of fertilizer, gives significantly higher and sustainable results than other combinations. Similar results i.e. significantly increased dry matter and seed yield of green gram was obtained by Rajkhowa (2000) with 75 per cent recommended dose of nitrogen and vermicompost @ 5 t ha<sup>-1</sup>. This might be due to the increased nodulation and biological activities.

Chinnamuthu and venkatkrishnan et al. (2001) compared FYM, vermicompost and some bio-fertilizers in an experiment in which graded chemical fertilizers were used with organic manures to sunflower crop. Results revealed that highest 100 g seed weight and seed grain yields could be obtained with 50 per cent NPK and 2 t vermicompost per ha. The yield obtained was higher than the 100 per cent NPK with FYM @ 5 t ha<sup>-1</sup>. Nehra and Hooda (2002) also concluded that vermicompost application to wheat crop proved to be better as compared to FYM, pressmud compost and chemical fertilizers for two successive seasons.

## **2.7. Effect of vermicompost on uptake of nutrients by maize crops :**

The yield and growth of plants depend upon the availability of nutrients in soil and uptake of nutrients from soil. Macro and micronutrient uptake improves the quality of the crop, which increased the market value of produce.

Kolodziej et al. (1994) conducted an experiment to assess the quality characters in cucumber and carrots grown on vermicompost. Both crops were analysed for nitrate, heavy metal and mineral element contents. In both cases crop quality was greater with vermicompost than with mineral fertilizers. Conjunctive use of vermicompost and urea in 1:3 ratio to

supply nitrogen to rice increased the dry matter production as well as uptake of most major nutrient elements i.e. N, P and K (Jadhav et al. 1997). In a experiment conducted on grape-vines by Venkatesh et al. (1997) nutrient content (macro as well as micro) was found to be increased with chemical fertilizers and vermicompost compared to only chemical fertilizers. Similar increase was observed by Washimkar (1997) in the study on mulberry crop with vermicompost. Uptake of macro and micronutrients increased with application of increased levels of vermicompost than control.

Damshetti (1997) found increased dry matter yield, protein content, oil content and seed yield of sunflower crop due to increased uptake with application of vermicompost. A study on yield and juice quality of sugarcane was carried out by Zende et al. (1998) with vermicompost and inorganic fertilizers application. He observed that juice quality of sugarcane increased by combination of NPK and vermicompost @ 10 t ha<sup>-1</sup>.

Kopczynski et al.(1999) conducted an experiment on sugar beet and found that vermicompost application before sowing enhance emergence and decrease weed infestation. Sugar content in beetroots was found to be increased significantly with the application of vermicompost with element calcium. Nethra et al. (1999) revealed that the application of vermicompost @ 15 t ha<sup>-1</sup> with 50 per cent NPK dose extends the vase-life of china aster flowers from 8.83 days to 9.33 days. As vermicompost increased the availability of micronutrients uptake of micronutrients by crop increased. Vermicompost had positive effect on the germination of green gram, as germination efficiency was 93.33 per cent. This might be due to the increased moisture content and supply of all nutrients in required quantity (Karmegam et al. 1999).

Results of experiment conducted by Karbauskiene (2000) demonstrated that ascorbic acid content of fennel notably increased when highest rates of vermicompost was applied. According to ascorbic acid index the best quality fennel obtained by applying vermicompost @ 10 t ha<sup>-1</sup>. Kucinskas and Karbauskiene (2000) also concluded from his experiment on cucumber that ascorbic acid could be increased by the application of vermicompost. Results obtained by Ramesh (2000) after conducting an experiment on ground-nut crop by applying vermicompost and fertilizers clearly indicate that damage caused by sucking pests significantly reduced by the application vermicompost compared to control and fertilizers. This might be due to increased K<sub>2</sub>O content in plant which increased the turgidity of plant cells.

Rajkhowa et al.(2000) conducted an experiment on green gram in which he found increased uptake of N, P and K by the application of 75 per cent recommended dose of nitrogen and 5 tonnes vermicompost per hectare than control and 100 per cent recommended dose of nitrogen. 100 per cent recommended dose of nitrogen through vermicompost application also gave significantly higher results than control. Uptake of nutrients increased with increasing level of vermicompost with decreased dose of inorganic fertilizers due to which TSS of ridge-gourd increased with the increasing vermicompost application (Sreenivas et al. 2000).

Vastrad et al. (2001) found that with 75 per cent recommended dose of fertilizers and 25 per cent vermicompost increased the uptake of nutrients and quality of ginger crop. Vermicompost increased level of nutrients in growth medium therefore uptake of nutrients and photosynthetic activities were higher (Nehra and Hooda 2002).

**MATERIAL AND  
METHODS**

### III MATERIALS AND METHODS

The details regarding the materials and methods adopted during present investigation entitled “Study of fertilizer use economy through vermicompost on maize crop ” is presented in this chapter.

#### 3.1 Materials

##### 3.1.1 Manures

###### Vermicompost :

Vermicompost was prepared in the laboratory following the standard method of preparation. All the ideal conditions were maintained for the purpose. Prepared vermicompost was analysed for its chemical composition (Table 1.)

##### 3.1.1.1 Substrate :

For the preparation of vermicompost soybean waste was collected from the farmyard of College of Agriculture, Pune – 5. About 40 Kg soybean waste used for preparation of vermicompost. Soybean substrate had 0.85, 0.74 and 0.72 per cent nitrogen, phosphorus and potassium content respectively with 35.21 C/N ratio.

##### 3.1.1.2 Earthworms :

Earthworms used for the preparation of vermicompost were *Eudrilus eugineae* spp. collected from a voluntary organization Inora, Kothrud, Pune-29.

**3.1.1.3. Cow dung :**

The fresh cow dung was collected from the Agronomy department, College of Agriculture, Pune-5. It was mixed with waste for the preparation of vermicompost.

**3.1.1.4. Plastic trays :**

Vermicompost was prepared in the plastic trays. These trays were collected from the Department of Bacteriology, College of Agriculture, Pune-5.

**3.1.1.5. Method of vermicompost preparation:**

Ground soybean waste was treated with cow dung slurry in proportion of 10:1 for fast decomposition. About eight kg of waste material was filled into each plastic tray. This material was kept for decomposition for about 15 days. Anaerobic conditions were maintained by covering trays with gunny bags. Moisture was maintained up to 50-60 percent for 15 days.

After 15 days earthworms were introduced in the plastic trays. Moisture and temperature were maintained up to 60 percent and 25- 30 °C respectively in the trays by regular application of water. Trays were covered with gunny bags. Vermicompost was drawn from trays after 45 days by withholding water supply in trays for 5 days and making pyramid shaped heap in trays only.

### 3.1.2 Fertilizers :

The inorganic fertilizers for nitrogen, phosphorus and potassium were applied in the form of urea (46 % N), Single super phosphate (16 % P<sub>2</sub>O<sub>5</sub>) and Muriate of potash (60 % K<sub>2</sub>O). The N dose of fertilizers was applied as per levels and was supplemented with vermicompost @ 5, 10, 15 and 20 t ha<sup>-1</sup>. The details of fertilizer application are given below in the Table 2.

**Table 1. Chemical Composition of vermicompost.**

Sr.No.	Parameter	Values
1	pH	7.18
2	EC (dS m <sup>-1</sup> )	1.32
3	C/N	17.27
4	N (%)	1.08
5	P (%)	0.99
6	K (%)	0.82
7	Fe (mg Kg <sup>-1</sup> )	24.54
8	Mn (mg Kg <sup>-1</sup> )	26.72
9	Zn (mg Kg <sup>-1</sup> )	19.45
10	Cu (mg Kg <sup>-1</sup> )	7.7

**Table 2. Quantity of fertilizers applied (g pot<sup>-1</sup>).**

Treatment No.	Urea	SSP	MOP	Vermicompost
1	0	0	0	0
2	11.6	16.68	1.66	0
3	9.28	16.68	1.66	223.21
4	6.94	16.68	1.66	446.42
5	4.64	16.68	1.66	669.64
6	2.32	16.68	1.66	892.85

### 3.1.3 Pots :

The cement pots of capacity 10-15 kg were used for pot culture experiment. Each pot was filled with 10 kg soil.

### 3.1.4 Seeds and Sowing :

The calculated quantity of nitrogen and phosphorus and potassium fertilizers <sup>were</sup> applied through solution in pots. The eight healthy seeds of maize crop (*Cv. African tall*) were sown in pots in circular manner and watered immediately. The six healthy maize seedlings were kept after 10 days of sowing. The moisture content of pots was maintained to field capacity throughout the growing period.

### 3.1.5 Soil :

The surface soil (0-15 cm) sample was collected from the Research Farm of Agriculture College, Pune. The soil collected was air dried, crushed in wooden mortar and pestle and sieved through 2 mm sieve. The soil sample was analysed for their initial physical and chemical properties (Table 3.).

**Table 3. Initial soil analysis.**

<b>Sr.No.</b>	<b>Particulars</b>	<b>Value</b>
<b>I. Physical properties :</b>		
1	Coarse sand (%)	5.10
2	Fine sand (%)	26.9
3	Silt (%)	24.5
4	Clay (%)	43.5
5	Textural class	Clay
<b>II. Chemical properties :</b>		
1	pH	7.59
2	EC (dS m <sup>-1</sup> )	0.23
3	Organic C (%)	0.51
4	Avail. N (kg ha <sup>-1</sup> )	206
5	Avail. P (kg ha <sup>-1</sup> )	23.08
6	Avail. K (kg ha <sup>-1</sup> )	315
<b>III. DTPA extractable:</b>		
1	Fe (mg Kg <sup>-1</sup> )	5.56
2	Mn (mg Kg <sup>-1</sup> )	8.32
3	Zn (mg Kg <sup>-1</sup> )	3.71
4	Cu (mg Kg <sup>-1</sup> )	33.68

### 3.2 Experimental Details :

The experiment was conducted with following treatments :

#### Treatment details:

1. Control
2. 100 % RDF
3. 80 % RDF + VC 05 t ha<sup>-1</sup>
4. 60 % RDF + VC 10 t ha<sup>-1</sup>
5. 40 % RDF + VC 15 t ha<sup>-1</sup>
6. 20 % RDF + VC 20 t ha<sup>-1</sup>

**Design :** Randomised block design with three replications.

Recommended dose of NPK : 120:60:60 kg ha<sup>-1</sup>.

**Note :** Recommended dose of fertilizers for P and K was applied alongwith levels of N and vermicompost as per treatments.

### 3.3 Harvesting of maize :

Three maize plants were harvested at 45 days after sowing and remaining three plants at 60 days of crop age. The plants were cut at surface of soil from pots. The adhered soil particles to the maize plants samples were removed with the help of nylon brush. The plant samples were washed with distilled water. The washed plant samples were dried in diffused sunlight in dust free laboratory. Then it was dried in oven at

about 70<sup>0</sup>C temperature till constant weight obtained. After drying the weights of plants as per respective treatments were recorded. These plant samples were then ground to fine powder form and used for analysis by adopting the standard laboratory procedure as given below.

### 3.4 Methods :

**Table 4. Analytical methods used for soil and plant analysis :**

Sr.	Parameter	Method	Reference
<b>1. Chemical :</b>			
1.	Soil pH	Potentiometric	Piper(1966)
2.	EC	Conductometric	Jackson (1973)
3.	Organic C	Walkley and Black	Jackson (1973)
4.	Total N	Micro-Kjeldahl	Jackson (1973)
5.	Available N	Alkaline permanganate	Subbiah and Asija (1956)
6.	Available P	0.5M NaHCO <sub>3</sub> at pH 8.5	Olsen et. al. (1954)
7.	Available K	Flame Photometric	Khudson and Beegle (1982)
<b>3. Plant analysis :</b>			
1.	Total N	Micro-kjeldahl	Parkinson and Allen (1975)
2.	Total P	Vanadomolybdate yellow colour	Jackson (1973)
3.	Total K	Flame Photometric	Jackson (1973)
4.	Micronutrients (Fe, Mn, Zn, Cu)	Atomic Absorption Spectro Photometric	Lindsay and Norvell (1978)

### 3.5 Statistical analysis :

The data recorded were statistically computed by adopting randomised block design (Panse and Sukhatme, 1967).



# RESULTS AND DISCUSSION

## IV RESULTS AND DISCUSSION

The pot culture experiment was conducted to study the fertilizer use economy through vermicompost on maize crop. The results of analysis are presented and discussed in this chapter.

### **4.1 Changes in the chemical properties of soybean substrate during the process of vermicomposting :**

During the process of vermicomposting upto 60 days chemical properties were studied and are presented in Table 5. It was observed that nutrients content of soybean waste increased after vermicomposting process.

During the process of vermicomposting, it was observed that pH of the substrate reduced to neutral from initial stage to final stage i.e. vermicompost. Electrical conductivity of substrate increased at 60 days stage than in 30 days stage. This might be due to the process of mineralization of organic matter by earthworms. During the mineralization process humic acid might be produced which is related to lowering the pH and increasing the CEC. Decrease in pH value is also associated with release of CO<sub>2</sub> gas during decomposition process. These results are in agreement with the results obtained by Albanell et al. (1988).

Remarkable reduction in C/N ratio of substrate from 35.21 to 17.27 was observed after vermicomposting process. Riffaldo and Levminzi (1982) reported that accelerated humification rate by earthworms resulted into lowering of C/N ratio. Similar reduction in C/N ratio was observed by Vasanthi and Kumarswamy ,(1999) while conducting experiment on various

waste materials and changes in their nutrient content by vermicomposting process.

Nitrogen content of soybean substrate increased from 0.85 per cent to 1.08 per cent during vermicomposting process. Phosphorus content of substrate was also increased during the process from 0.74 per cent to 0.99 per cent from initial stage to final stage of vermicompost preparation. Similar increased P status in vermicompost was recorded by Guntharaj and Ravignanan (1996) from sericulture waste. Potassium content of soybean waste increased from 0.72 per cent to 0.82 per cent after 60 days interval of vermicomposting. The increased N, P and K content in vermicompost was due to earthworms which accelerated the mineralization of organic matter resulted in reduction of C/N ratio in vermicompost. Similar increase in nutrient content of substrate was also observed by Hangarge et al. (1998) in the experiment conducted on various animal and plant waste material. Results are in agreement with the results obtained by Vasanthi and Kumarswamy (1999) in the studies on plant wastes like parthenium and ipomea weeds, sugarcane trash etc.

**Table 5. Changes in chemical properties during vermicomposting of soybean substrate.**

Parameters	Days		
	0	30	60
pH	-	7.40	7.18
EC (dS m <sup>-1</sup> )	-	1.24	1.32
C/N	35.21	23.50	17.27
N (%)	0.85	0.96	1.08
P (%)	0.74	0.85	0.99
K (%)	0.72	0.78	0.82

#### **4.2 Effect of integrated use of inorganic fertilizers and vermicompost on the dry matter yield of the maize crop:**

Data in respect of dry matter yield of maize plants at tasseling stage and at harvesting stage influenced by vermicompost application is presented in Table 6. The application of organic matter to soil helps in increasing the dry matter as well as grain yield (Biswas et al. 1971 and Tiwari and Pathak 1980). Significant increase in the dry matter yield of maize crop can be noticed from Table 6.

At tasseling stage, dry matter weight of plants receiving vermicompost @ 10 t ha<sup>-1</sup> with 60 per cent recommended dose of nitrogen fertilizers was more than all treatments. Treatment in which 100 per cent recommended dose of nitrogen fertilizers applied yielded more dry matter yield but was at par all other treatments where vermicompost was applied. At harvesting stage also the treatment with 60 per cent recommended dose of N fertilizers and 10 t ha<sup>-1</sup> vermicompost increased the dry matter yield of crop significantly than other treatments. Though there was no significant increase in dry matter yield of crop in the treatments but the application of vermicompost certainly increased the dry matter yield of crop. About 20- 27 per cent increase in dry matter weight was observed due to vermicompost application.

This dry matter yield of crop might be increased due to the increased availability of the nutrients through vermicompost, which consequently leads to increase in the uptake of nutrients by crop. Vermicompost application enhanced the microbial activity in soil, thereby increased the nutrients content of the soil (Rajkhowa et al. 2000).

Patil and Patil (2000) conducted an experiment on fodder sorghum and reported significantly increased green and dry fodder yield with the application of vermicompost.

**Table 6. Effect of integrated use of inorganic fertilizers and vermicompost on the dry matter yield of maize crop at tasseling and harvesting stage.**

Treatments	Tasseling stage	Harvesting stage
	----- g pot <sup>-1</sup> -----	
Control	9.48	52.23
100%RDF	12.63	60.85
80%RDF + VC 05 t ha <sup>-1</sup>	11.17	60.40
60%RDF + VC 10 t ha <sup>-1</sup>	15.11	66.60
40%RDF + VC 15 t ha <sup>-1</sup>	10.73	57.57
20%RDF + VC 20 t ha <sup>-1</sup>	10.01	54.68
Mean	11.52	58.89
SE ±	0.107	0.888
CD at 0.05	0.337	2.80

### 4.3 Effect of integrated use of inorganic fertilizers and vermicompost on the uptake of nutrients by the maize crop at tasseling stage :

#### 4.3.1 Macronutrients :

##### 4.3.1.1 Nitrogen :

The nitrogen content of maize crop at tasseling stage significantly influenced by vermicompost application in conjunction with inorganic fertilizers over control and farmer's practice i.e. full dose of NPK through inorganic fertilizers (Table. 7). Maximum nitrogen uptake (0.564 g plant<sup>-1</sup>) was observed in treatment four in which 40 per cent NPK dose was replaced by 10 t ha<sup>-1</sup> vermicompost. Increase in uptake of nitrogen

was significant over the uptake in control treatment  $0.264 \text{ g plant}^{-1}$  and uptake in 100 per cent dose  $0.448 \text{ g plant}^{-1}$ . Similar findings were also recorded by Jadhav et al. (1997)

#### **4.3.1.2 Phosphorus :**

Uptake of phosphorus was not affected by the application of vermicompost at tasseling stage. It ranged between  $0.051 \text{ g plant}^{-1}$  to  $0.564 \text{ g plant}^{-1}$  (Table 7). Though values showed increasing trend in uptake due to application of vermicompost over control, the results were nonsignificant.

#### **4.3.1.3 Potassium :**

Highest uptake of potassium was recorded in treatment with reduced dose of 60 per cent recommended dose of N fertilizers through inorganic fertilizers and vermicompost @  $10 \text{ t ha}^{-1}$ . Potassium uptake of plants increased significantly (Table 7) upto  $0.253 \text{ g plant}^{-1}$  while under control it was  $0.170 \text{ g plant}^{-1}$  and with full NPK dose  $0.220 \text{ g plant}^{-1}$ . Results obtained are inline with those obtained by Venkatesh et al. (1997).

This might be due to mineralization process. The mineralization process of vermicompost released the macronutrients resulting in their increased availability and consequently in increased uptake of macronutrients. This attributed to increased dry matter yield of crop.

### 4.3.2 Micronutrients :

Significant increase was also noticed in uptake of micronutrients Fe, Mn, Zn and Cu in maize crop at tasseling stage from results presented in the Table 8.

#### 4.3.2.1 Iron :

Data revealed that the uptake of Fe by maize crop increased significantly upto  $40.12 \text{ mg kg}^{-1}$  when 10 tons vermicompost per ha applied in conjunction with 60 per cent RDF. It was found superior to uptake in control treatment ( $29.36 \text{ mg kg}^{-1}$ ) and  $37.51 \text{ mg kg}^{-1}$  100 per cent RDF. The results obtained are congruent with the results observed by Reddy and Reddy (1999).

**Table 7. Effect of integrated use of inorganic fertilizers and vermicompost on the uptake macronutrients by maize crop at tasseling stage.**

Treatments	N	P	K
	----- g plant <sup>-1</sup> -----		
Control	0.264	0.051	0.170
100 %RDF	0.448	0.060	0.220
80%RDF + VC 05 t ha <sup>-1</sup>	0.354	0.056	0.197
60%RDF + VC 10 t ha <sup>-1</sup>	0.564	0.067	0.253
40%RDF + VC 15 t ha <sup>-1</sup>	0.360	0.054	0.190
20%RDF + VC 20 t ha <sup>-1</sup>	0.299	0.053	0.180
Mean	0.318	0.084	0.202
SE $\pm$	0.0175	0.0661	0.0045
CD at 0.05	0.0551	NS	0.0144

#### 4.3.2.2 Manganese :

The uptake of manganese by maize at tasseling stage was also increased. Uptake of Mn ranged from  $1.68 \text{ mg kg}^{-1}$  to  $2.35 \text{ mg kg}^{-1}$ . Uptake of manganese was also higher than farmer's practice ( $2.03 \text{ mg kg}^{-1}$ ). Similar for uptake of Mn recorded by Venkatesh et al. (1997).

#### 4.3.2.3 Zinc :

Zinc uptake by maize at tasseling stage was increased by application of vermicompost in conjunction with inorganic fertilizers. Maximum Zn uptake ( $5.38 \text{ mg kg}^{-1}$ ) was recorded in treatment comprising  $20 \text{ t ha}^{-1}$  vermicompost whereas minimum Zn uptake ( $3.92 \text{ mg kg}^{-1}$ ) was observed in control pot and  $4.74 \text{ mg kg}^{-1}$  Zn uptake in treatment where chemical fertilizers alone applied. Other treatments were at par with each other. Patil (1993) showed similar increase in uptake of Zn by maize due to use of vermicompost.

#### 4.3.2.4 Copper :

The uptake of copper influenced positively by the application of vermicompost in conjunction with reduced dose of nitrogen. Uptake increased upto  $5.52 \text{ mg kg}^{-1}$  due to application of vermicompost @  $10 \text{ t ha}^{-1}$  in combination with 60 per cent N through inorganic fertilizer followed by treatment where full dose of NPK were applied ( $5.13 \text{ mg kg}^{-1}$ ) and  $4.45 \text{ mg kg}^{-1}$  in control treatment. Results obtained are congruent with those obtained by Reddy and Reddy (1997).

This again might be due to mineralization process, which increased availability of macronutrients and increased uptake of micronutrients. The

presence of various enzymes and acids produced during vermicomposting increased the availability of micronutrients to the plants.

**Table 8. Effect of integrated use of inorganic fertilizers and vermicompost on the uptake of micronutrients by maize crop at tasseling stage.**

Treatments	Fe	Mn	Zn	Cu
	----- mg kg <sup>-1</sup> -----			
Control	29.36	1.68	3.92	4.450
100 %RDF	37.51	2.03	4.74	5.13
80%RDF + VC 05 t ha <sup>-1</sup>	34.24	1.85	4.84	4.93
60%RDF + VC 10 t ha <sup>-1</sup>	40.12	2.35	5.38	5.52
40%RDF + VC 15 t ha <sup>-1</sup>	32.75	1.79	4.39	4.66
20%RDF + VC 20 t ha <sup>-1</sup>	30.36	1.75	4.15	4.51
Mean	34.06	1.92	4.57	4.87
SE ±	.726	0.045	0.135	0.048
CD at 0.05	2.28	0.144	0.426	0.152

#### 4.4 Effect of integrated use of inorganic fertilizers and vermicompost on the uptake of nutrients at the harvesting stage :

##### 4.4.1 Macronutrients :

Data in respect of uptake of macronutrients at harvesting stage are presented in the Table 9. These results obtained showed similar trend as obtained at tasseling stage of crop growth.

##### 4.4.1.1 Nitrogen :

Uptake of nitrogen increased significantly when dose of N through chemical fertilizers reduced and was supplemented with vermicompost over control. It was minimum in (0.614 g plant<sup>-1</sup>) control

treatment and was highest in treatment ( $0.778 \text{ g plant}^{-1}$ ) at 60 per cent recommended dose of nitrogen fertilizers plus  $10 \text{ t ha}^{-1}$  vermicompost applied. Other treatments of vermicompost with reduced dose of chemical fertilizers showed increased nitrogen uptake over control treatment. Results are congruent with the results obtained by Washimkar (1997).

#### **4.4.1.2 Phosphorus :**

Application of vermicompost showed marked increase on uptake of phosphorus by the plants at harvesting stage. It ranged from  $0.096 \text{ g plant}^{-1}$  to  $0.163 \text{ g plant}^{-1}$ . Similar observations on uptake of phosphorus were also reported by Vasanthi and Kumarswamy (1999).

#### **4.4.1.3 Potassium :**

Use of vermicompost alongwith chemical fertilizers had appositive effect on potassium uptake by plant. The minimum uptake ( $0.403 \text{ mg kg}^{-1}$ ) was observed in control treatment and maximum ( $0.533 \text{ mg kg}^{-1}$ ) in 100 per cent recommended dose of N fertilizers and was highest  $0.597 \text{ g plant}^{-1}$  in treatment with 60 per cent N through inorganic fertilizers and vermicompost @  $10 \text{ t ha}^{-1}$ . Other treatments of vermicompost incombination with inorganic fertilizers had more or less similar uptake of K. These results obtained matches with those obtained by Ramesh (2000).

**Table 9. Effect of integrated use of inorganic fertilizers and vermicompost on the uptake of macronutrients by maize crop at harvesting stage.**

Treatments	N	P	K
	----- g plant <sup>-1</sup> -----		
Control	0.614	0.096	0.403
100 %RDF	0.705	0.142	0.533
80%RDF + VC 05 t ha <sup>-1</sup>	0.672	0.120	0.485
60%RDF + VC 10 t ha <sup>-1</sup>	0.778	0.163	0.597
40%RDF + VC 15 t ha <sup>-1</sup>	0.652	0.109	0.436
20%RDF + VC 20 t ha <sup>-1</sup>	0.640	0.102	0.424
Mean	0.677	0.122	0.480
SE $\pm$	0.0722	0.0058	0.0116
CD at 0.05	0.0227	0.018	0.0366

#### 4.4.2 Micronutrients :

Data pertaining to uptake of micronutrients are presented in Table 10. More or less trend was observed at harvesting stage as compared to tasseling stage.

##### 4.4.2.1 Iron :

The uptake of iron was increased at harvesting stage. It increased in similar tune as that of tasseling stage. Fe uptake was highest in the treatment where N was reduced to 60 per cent and vermicompost @ 10 t ha<sup>-1</sup> (92.03 mg kg<sup>-1</sup>) was applied followed by 100 per cent N through inorganic fertilizers (88.46 mg kg<sup>-1</sup>). Similar increased uptake of iron was also noticed by Reddy and Reddy (1999).

#### 4.4.2.2 Manganese :

The maximum Mn uptake by maize ( $5.40 \text{ mg kg}^{-1}$ ) was observed where 60 per cent N through chemical fertilizers supplemented with vermicompost @  $10 \text{ t ha}^{-1}$  and it was lowest ( $4.56 \text{ mg kg}^{-1}$ ) under the control treatment. Venkatesh et al. (1997) also reported that the uptake of Mn increased due to addition of vermicompost.

#### 4.4.2.3 Zinc :

Vermicompost application in combination with inorganic fertilizers increased the uptake of zinc by maize crop at harvesting stage. The minimum uptake of Zn was  $14.10 \text{ mg kg}^{-1}$  in control treatment and increased upto  $16.36 \text{ mg kg}^{-1}$  in the treatment comprising vermicompost @  $10 \text{ t ha}^{-1}$  + 60 nitrogen through inorganic fertilizers. Similar results were recorded by Venkatesh et al. (1997).

#### 4.4.2.4 Copper :

Application of vermicompost in conjunction with inorganic fertilizers improved the uptake of copper in plants. It ranged from  $4.40 \text{ mg kg}^{-1}$  to  $5.7 \text{ mg kg}^{-1}$ . Maximum uptake of Cu was observed in the treatment consisting vermicompost @  $10 \text{ t ha}^{-1}$  with reduced dose of N through inorganic fertilizers. Washimkar (1997) also found the favourable effect of vermicompost on uptake of Cu by mulberry.

**Table 10. Effect of integrated use of inorganic fertilizers and vermicompost on the uptake of micronutrients by maize crop at harvesting stage.**

Treatments	Fe	Mn	Zn	Cu
	----- mg kg <sup>-1</sup> -----			
Control	72.60	4.56	14.10	4.40
100 %RDF	88.46	5.06	15.86	5.10
80%RDF + VC 05 t ha <sup>-1</sup>	84.96	4.86	15.46	4.86
60%RDF + VC 10 t ha <sup>-1</sup>	92.03	5.40	16.36	5.70
40%RDF + VC 15 t ha <sup>-1</sup>	81.50	4.73	14.80	4.73
20%RDF + VC 20 t ha <sup>-1</sup>	77.67	4.63	14.33	4.66
Mean	82.87	4.87	15.15	4.91
SE ±	1.41	.035	.081	.035
CD at 0.05	4.47	0.112	0.25	0.11

#### 4.5 Effect of integrated use of inorganic fertilizers and Vermicompost on the soil fertility after the harvest of crop :

##### 4.5.1 pH :

Data on soil reaction after the harvest of maize crop are presented in Table 11. Results indicated that pH of soil did not show any changes due to various treatments. Almost soil reaction ranged from 7.0 to 7.3. It might be happened due to production of different acids while decomposition process of vermicompost. Similar results were reported by Patil (1993).

##### 4.5.2 Electrical conductivity (EC):

A slight increase in electrical conductivity was also noticed due to application of vermicompost along with chemical fertilizers. Electrical conductivity ranged from 0.237 dS m<sup>-1</sup> to 0.357 dS m<sup>-1</sup> and found to be at par with each other.

### 4.5.3 Organic carbon :

Data on organic carbon content of soil after the harvest of crop are presented in Table 11. Highest organic carbon content was observed in treatment with vermicompost @ 20 t ha<sup>-1</sup> supplemented with inorganic fertilizers. Increased dose of vermicompost reflected on organic carbon content of soil at harvesting stage. These results are in agreement with the results obtained by Nehra and Hooda (2002).

**Table 11. Effect of integrated use of inorganic fertilizers and vermicompost on the pH, EC and organic carbon content of soil after the harvest of maize crop.**

<b>Treatments</b>	<b>PH (1: 2.5)</b>	<b>EC (dS m<sup>-1</sup>)</b>	<b>Org. C (%)</b>
Control	7.2	0.237	0.580
100 % RDF	7.3	0.250	0.653
80%RDF + VC 05 t ha <sup>-1</sup>	7.1	0.303	0.713
60%RDF + VC 10 t ha <sup>-1</sup>	7.0	0.317	0.743
40%RDF + VC 15 t ha <sup>-1</sup>	7.1	0.333	0.800
20%RDF + VC 20 t ha <sup>-1</sup>	7.0	0.357	0.843
Mean	7.1	0.299	0.722
SE ±	0.057	0.0075	0.0096
CD at 0.05	0.18	0.023	3.05

### 4.5.4 Macronutrients :

#### 4.5.4.1 Available nitrogen :

Data regarding available nitrogen content of soil are presented in Table 12. It was observed that available nitrogen content of soil increased from 201.74 kg ha<sup>-1</sup> to 250.87 kg ha<sup>-1</sup> in treatment where vermicompost @10 t ha<sup>-1</sup> and 60 per cent N dose was applied. The significant increased in available nitrogen content of soil over control and

100 per cent NPK dose might be due to decomposition process and mineralization of vermicompost. Results indicated that the substitution of recommended dose of nitrogen fertilizers through vermicompost increased the available nitrogen status of soil. Results obtained are in confirmation with the results obtained by Rao and Dhakole (1994).

#### **4.5.4.2 Available phosphorus :**

The available phosphorus content of soil at harvest was significantly increased over the control. The treatment comprising 60 per cent N through inorganic fertilizers with 10 t ha<sup>-1</sup> vermicompost was significantly superior over all the treatments. Available phosphorus content at harvest of maize ranged from 10.76 to 16.46. Joseph et al. reported that the available phosphorus in soil increased due to addition of oxidisable material by vermicompost. The treatment comprising dose of N supplemented with vermicompost were at par with each other except treatment with vermicompost @ 10 t ha<sup>-1</sup> plus 60 per cent N through inorganic fertilizers. Rajkhowa et al. (2000) also found the results on available phosphorus status of soil due to supplementation with vermicompost.

#### **4.5.4.3 Available potassium :**

The data on available potassium content of soil after harvest are presented in Table 12. The available potassium content of soil was significantly increased due to vermicompost application. The available potassium of soil ranged from 216.33 to 295 kg ha<sup>-1</sup> irrespective of treatments. However application of N through vermicompost proved to be significantly increased availability of potassium content over each other.

addition of organic matter through vermicompost. Vasanthi and Kumarswamy (1999) and Rajkhowa et al. (2000) also obtained similar results.

**Table 12. Effect of integrated use of inorganic fertilizers and vermicompost on the macronutrient content of soil after the harvest of maize crop.**

Treatments	Avail.N	Avail.P	Avail.K
	-----kg ha <sup>-1</sup> -----		
Control	201.74	10.76	216.33
100 %RDF	239.38	13.66	277.00
80%RDF + VC 05 t ha <sup>-1</sup>	229.97	13.40	267.00
60%RDF + VC 10 t ha <sup>-1</sup>	250.87	16.46	295.00
40%RDF + VC 15 t ha <sup>-1</sup>	225.70	12.73	257.30
20%RDF + VC 20 t ha <sup>-1</sup>	215.33	12.43	248.66
Mean	226.83	13.09	258.55
SE $\pm$	1.19	0.088	1.52
CD at 0.05	3.75	2.57	4.80

#### 4.5.5 Micronutrients :

##### 4.5.5.1 Iron :

The micronutrients content after the harvest of crop revealed that maximum available iron content (69.49 mg kg<sup>-1</sup>) was observed in the treatment where vermicompost was applied @ 10 t ha<sup>-1</sup> with 60 per cent recommended dose of N fertilizers. This might be due to mineralization of Fe. The similar results were also recorded by Damshetti (1997) in experiment with sunflower.

#### **4.5.5.2 Manganese :**

The data on available soil manganese content of are presented in Table 13. Observations recorded showed that application of 10 t ha<sup>-1</sup> vermicompost with 60 per cent reduced N dose proved to be better. It ranged from 10.16 mg kg<sup>-1</sup> to 15.43 mg kg<sup>-1</sup> irrespective of treatment. Similar increase in Mn content of soil was also noticed by Patil (1993).

#### **4.5.5.3 Zinc :**

Data pertaining zinc content of soil are presented in Table 13. The results showed that zinc content of soil after the harvest of crop in various treatments was almost similar. It remained unchanged by vermicompost application.

#### **4.5.5.4 Copper :**

The treatment comprising 60 per cent reduced N dose alongwith 10 t ha<sup>-1</sup> vermicompost was significantly superior over all the treatments. So also the treatments consisting application of vermicompost alongwith inorganic N fertilizers were at par with each other. Maximum Cu content (7.46 mg kg<sup>-1</sup>) was observed in treatment where 10 t ha<sup>-1</sup> vermicompost was supplemented with reduced dose of N. Patil (1993) also noticed increased copper concentration in soil due to use of vermicompost.

Mineralization of vermicompost released the macronutrients and micronutrients during decomposition of organic matter.

Organic acids produced in transformation cycles helped to solubilize the nutrients (Sarkar et al.1998).

**Table 13. Effect of integrated use of inorganic fertilizers and vermicompost on the micronutrient content of soil after the harvest of maize crop.**

Treatments	Fe	Mn	Zn	Cu
	-----mg kg <sup>-1</sup> -----			
Control	40.16	10.16	27.13	4.36
100 %RDF	67.63	13.63	29.96	6.36
80%RDF + VC 05 t ha <sup>-1</sup>	54.86	12.73	29.73	5.90
60%RDF + VC 10 t ha <sup>-1</sup>	69.49	15.43	31.83	7.46
40%RDF + VC 15 t ha <sup>-1</sup>	50.90	12.10	31.33	5.63
20%RDF + VC 20 t ha <sup>-1</sup>	48.73	11.33	28.00	5.06
Mean	56.93	12.56	29.66	5.80
SE $\pm$	0.339	0.106	1.33	0.056
CD at 0.05	1.07	0.337	NS	0.165

# SUMMARY AND CONCLUSION

## V SUMMARY AND CONCLUSION

The present investigation was undertaken to study fertilizers use economy for maize crop through vermicompost at the College of Agriculture, Pune-5 during year 2002-2003. A potassium culture experiment was carried out to study the changes in the composition of soybean waste material by the action of earthworms while vermicomposting process and find out the effects of vermicompost application alongwith reduced level of recommended nitrogen fertilizer dose on the uptake of nutrients by crop grown and fertility status of the soil. The vermicompost was prepared in laboratory as per prescribed method and it was applied to maize crop as per treatments. Maize crop was grown under pot house. The results of the experiment are summarized below.

### 5.1 Summary :

#### **Changes in the chemical properties of soybean substrate during the process of vermicomposting :**

Soybean waste material was collected and analysed for its chemical composition. Firstly it was partially decomposed for 15 days and then earthworms of species *Eudrilus eugineae* were introduced to it for vermicompost preparation. During the process of vermicomposting material was analysed at 30 to 60 days interval.

From the analytical results, it was observed that conversion of waste material into vermicompost increased the nutrients content of

waste. The wide C/N ratio of substrate was narrowed from 35.21 to 15.27. Vermicompost, the final end product prepared had neutral pH. Electrical conductivity of vermicompost was slightly increased during the process of vermicomposting at final stage.

The total nitrogen content of soybean substrate was increased after vermicomposting process. Phosphorus and potassium content of substrate was also increased during vermicomposting process.

#### **Effect of integrated use of inorganic fertilizers and vermicompost on the uptake of nutrients :**

Application of vermicompost with inorganic fertilizers showed promising results on the uptake of the nutrients by maize crop. Uptake of macronutrients as well as micronutrients was increased due to vermicompost application. The increased in uptake was reflected on the dry matter yield of crop. Application of vermicompost in conjunction with reduced levels of inorganic N fertilizers increased dry matter production in all treatments.

At tasseling stage uptake nitrogen, phosphorus and potassium was maximum in treatment where vermicompost @ 10 t ha<sup>-1</sup> with 60 per cent recommended dose of N fertilizers was applied. Uptake of nutrients was more at harvesting stage. The micronutrient uptake by maize crop was also increased due to vermicompost application. Similar treatment showed greater impact on uptake of micronutrient due to vermicompost application with chemical fertilizers. Interaction of chemical fertilizers with vermicompost increased the uptake of Fe, Mn,

Zn and Cu at tasseling stage as well as at harvesting stage. Due to vermicompost application soil microbial processes were enhanced and which leads to increased availability of nutrients and thereby increased uptake of nutrients.

### **Effect of integrated use of inorganic fertilizers and vermicompost on the fertility of soil :**

Application of organic manures improved the soil fertility. Vermicompost added as an organic amendment increased the nutrients status of the soil. The pH of soil was slightly decreased and which increased availability of nutrients in soil. Electrical conductivity of soil increased with application of vermicompost. Organic carbon content of soil was also increased.

Vermicompost application increased the mineralization process in soil, which thereby improved nutrient status of soil. Available nitrogen, phosphorus and potassium content of soil was more in treatment where vermicompost @ 10 t ha<sup>-1</sup> alongwith reduced N dose was applied. Micronutrients status of soil was also improved.

### **5.2 Conclusions :**

1. Process of vermicomposting reduced the pH of substrate used. During the process of vermicomposting electrical conductivity of substrate increased with the time interval. Due to process of decomposition by earthworms the wide C/N ratio was narrow down.

2. The nitrogen, phosphorus and potassium content in vermicompost was markedly increased during process of vermicomposting than initial nutrients content of substrate.
3. Vermicompost in combination with chemical fertilizers increased the uptake of nitrogen, phosphorus and potassium by the maize crop. Uptake of micronutrients was also increased due to the vermicompost application.
4. Vermicompost application improved soil conditions. The pH of the soil was slightly decreased however electrical conductivity and organic carbon content of soil were increased due to vermicompost application.
5. Vermicompost supplementation in conjunction with inorganic fertilizers improved the soil fertility status after the harvest of maize crop. Available N, P and K status and micronutrients viz. DTPA extractable Fe, Mn, Zn and Cu in soil were increased due to application of vermicompost with reduced levels of N than inorganic fertilizers alone.
6. Among the various levels of nitrogen dose with increased dose of vermicompost, application of 72 kg N ha<sup>-1</sup> along with vermicompost @ 10 t ha<sup>-1</sup> to maize showed pronounced positive effect on dry matter yield and to maintain soil health.

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## VI LITERATURE CITED

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