

**EFFECT OF VERMICOMPOST AND FYM ON SOIL
ENZYMES IN SWELL SHRINK SOIL**

by

MISS DHANAWADE MANISHA RAJARAM

(Reg. No. 98062)

A Thesis submitted to the

**MAHATMA PHULE KRISHI VIDYAPEETH, RAHURI,
DIST. AHMEDNAGAR (MAHARASHTRA), INDIA**

In partial fulfilment of the requirements for the degree
of

MASTER OF SCIENCE (AGRICULTURE)

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AGRICULTURAL CHEMISTRY

**DEPARTMENT OF AGRICULTURAL CHEMISTRY
AND SOIL SCIENCE,
POST GRADUATE INSTITUTE,
MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI - 413 722, DIST. AHMEDNAGAR (M.S.), INDIA
2000.**

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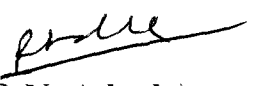
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2000.**

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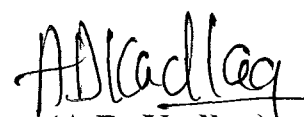
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This is to certify that the thesis entitled, "***EFFECT OF VERMICOMPOST AND FYM ON SOIL ENZYMES IN SWELL SHRINK SOIL***", submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri in partial fulfilment of the requirements for the degree of ***MASTER OF SCIENCE (AGRICULTURE) in AGRICUTURAL CHEMISTRY***, embodies the results of a piece of *bona fide* research work carried out by ***Miss Dhanawade Manisha Rajaram*** under my guidance and supervision and that no part of the thesis has been submitted to any other university for a degree, diploma or publication

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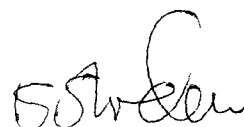
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Place · MPKV, Rahuri

Date · 7/6/2000



(MISS M.R. DHANAWADE)

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ABBREVIATIONS

@	At the rate of
a.i	Active ingredient
≅	Approximately
ANSA ✓	Amino Naphthol Sulphonic Acid
C	Carbon
°C	Degree centigrade
C D	Critical difference
cm	Centimetre (s)
cmole	Centimole (s)
conc	Concentrated
dS m ⁻¹	Deci Siemens per metre
<i>et al</i>	At all (and others)
EC	Enzyme Commission
FYM	Farm yard manure
g	Gram (s)
ha	Hectare
hr	Hour
i.e.	Id est (that is)
kg	Kilogram (s)
L	Litre
m	Metre (s)
M	Molar
MUB ✓	Modified Universal Buffer
mg	Milligram (s)
Mg	Megagram (s) = 1000 kg
mL	Millilitres

Abbreviations Contd ...

N	Nitrogen
<u>N</u>	Normal
nm	Nanometres
P	Phosphorus
P ₂ O ₅	Phosphorus pentaoxide
PMC	Press mud cake
r	Correlation coefficient
SE	Standard error
THAM ✓	Tris (Hydoxy methyl) Amino Methane
μg	Microgram
μM	Micro moles
viz ,	Videlicent (namely)
yr	Year

ABSTRACT**EFFECT OF VERMICOMPOST AND FYM ON SOIL ENZYMES IN
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By
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A candidate for the degree
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Research guide	Dr. A.D Kadlag
Department	: Agril. Chemistry and Soil Science

The investigation was carried out to study the effect of vermicompost and FYM on soil enzymes in swell shrink soil under laboratory conditions. The soil used for pot culture experiment was medium black, alkaline, calcareous in nature and belonged to Sawargaon series (Vertic ustropepts).

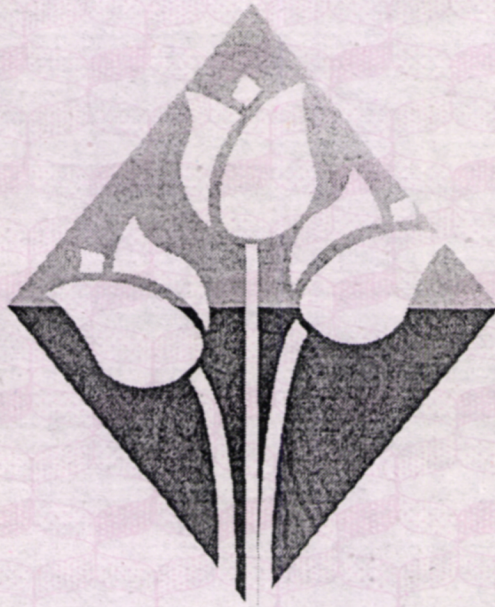
The results revealed that the application of vermicompost and farm yard manure significantly enhanced the available nitrogen and phosphorus over control throughout the incubation period. The higher levels of vermicompost and farm yard manure application @ 40 and 50 Mg ha⁻¹ found significantly superior over 10, 20 and 30 Mg ha⁻¹, respectively.

The activity of acid phosphatase and urease soil enzyme was significantly increased by vermicompost and farm yard manure application. The acid phosphatase enzyme activity was initially increased up to 14th days and 60th days of incubation. It was declined at 21st, 28th, 35th and 45th days of incubation. The application of vermicompost was found beneficial for urease enzyme activity over FYM. The increased levels of vermicompost and FYM significantly increased the activity of acid phosphatase and urease throughout the incubation period.

The application of vermicompost showed significant positive correlation of acid phosphatase enzyme with available phosphorus and negative correlation with urease enzyme in soil.

The available nitrogen had significant negative correlation with acid phosphatase enzyme and significant positive correlation with available phosphorus in FYM treatment.

Chapter Opener Page



INTRODUCTION

1. INTRODUCTION

The use of organic manures held a prestigious position with farmers in the past, but subsequently the introduction of high analysis fertilizers cast a shadow on their spread. This was due to the advent of high yielding varieties and increased area under assured irrigation. It is well known that addition of organic manures has shown considerable increase in crop yield and exert significant influence on physical, chemical and biological properties of soil. Use of inorganic fertilizers along with organic manures prepared from available materials would not only improve soil health but also help to sustain crop productivity. Their use must, therefore, be encouraged.

India has vast potential of local manurial resources viz., animal wastes, crop residues, green manures, rural and urban composts, city garbages, byproducts of agro-industries and recently introduced vermicompost.

Vermicompost technology, is an aspect of biotechnology involving the use of earthworms on versatile recycling of non-toxic organic solid waste to the soil resulting in development of sustainable agriculture and waste land development. Vermicompost is a mixture of earthworm cocoons (eggs) and well decomposed organic matter which has various nutrients. Vermicompost prepared from different organic wastes with different earthworm species contains major and minor plant nutrients (Shinde *et al*, 1993).

Vermicompost contains various amino acids, minerals and micro-organisms which humify the organic matter in surrounding soil and acts as a biofertilizer for plants. The degraded organic matter by worm activity is called 'vermicompost' which can be used as top soil or organic manure in field to prevent organic carbon deficiency and soil erosion. The casts also form suitable base for releasing nutrients to higher plants (Atlavintye and Vanages, 1982). Vermicompost is also rich in vitamins, enzymes, antibiotics and growth hormones. It provides balanced nutrients to plant giving them resistance against pests and diseases. Eroded as well as saline soils are being rehabilitated through vermicompost biotechnology with noticeable results within a short period.

Use of organic manure in the present system of agriculture is increasing day by day because of its utility not only in improving the physical, chemical and biological properties of soil but also in maintaining the soil health without pollution. Addition of organic manure in any form helps in maintaining the organic matter and fertility level in soil. The role of organic manure in improving humic substances for the growth of plant is direct as well as indirect. The direct effects are enhancing population of beneficial microbes and their activities in organic matter degradation, biological nitrogen fixation and improvement in the physical condition of the soil. The important role of organic material in increasing and maintaining mulberry field productivity has been recognized, but the mechanism of its function has not been clearly analysed (Inamatsu and Kiuchi, 1988).

Organic matter recycling in soil involves biochemical and physico-chemical reactions with the biochemical processes being mediated

by micro-organisms, plant roots and soil animals. All biochemical reactions are catalysed by enzymes. Most of the enzymes added to soil by decaying microbial tissues and by plant and animal residues are likely degraded by soil protease and what remains is incorporated with the humus. Therefore, soil is a system of humus and minerals containing both immobilized enzymes and occluded microbial cells.

Some of the biochemical transformations in soil are catalysed by enzymes found outside the living soil organisms. Part of the physiological activity of many soil organisms is to release enzymes into the soil for example, proteinases and cellulases hydrolyse large macromolecules and the degradation products become available as nutrients for the organisms. It can be assumed that some of these enzymes remain in the soil in an active state outside the living cells.

Not all the known enzymatic reactions in soil can be ascribed to the microbial extracellular enzymes, many are catalyzed by typical intracellular enzymes. Upon the death of cells and the collapse of their walls and rupture of their membranes, some protoplasmic constituents are released into soil. Although most of the released material may be quickly metabolized by other living organisms, some may be enzymes that persist in soil for a certain period in an active state or are quite resistant to denaturation in a soil environment.

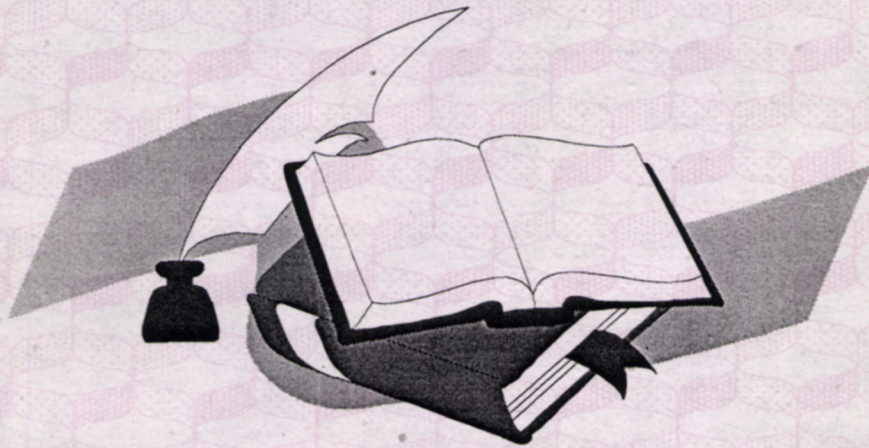
The enzyme activity in soil has been found to be affected by both the vermicompost and farm yard manure in general. So the two important enzymes, urease and acid phosphatase associated with the cycling of nitrogen and phosphorus, the major elements required by plants, were

taken for study. The importance of soluble organic phosphorus as a source of phosphorus to plants depends on the amount and forms of organic phosphorus and presence of appropriate phosphatase for hydrolysis of organic phosphorus.

Based on the foregoing, the present investigation was planned with the following objectives .

- i) To study the effect of vermicompost and farm yard manure on soil enzymes viz., urease and acid phosphatase in swell shrink soil, and
- ii) To find out the correlation between soil enzymes, vermicompost, and farm yard manure with available N and P.

Chapter Opener Page



REVIEW OF
LITERATURE

2. REVIEW OF LITERATURE

The use of organic manures gained importance in increasing crop production by maintaining soil productivity and soil properties viz , physical, chemical and biological. The biological property is highly correlated with organic matter content of soil which governs the productivity and fertility of soil. The agricultural scenario in India has recently changed considerably with the introduction of high yielding varieties of crops, intensive cropping system, use of high analysis fertilizers. The information on the effect of organic manures on soil enzymes and nutrient availability is, however, lacking.

An attempt has been made in this chapter in view of supporting the present investigation under the following subheads :

2.1 Effect of vermicompost and FYM on nutrient status of soil

2.1.1 Nitrogen

Naik and Ballal (1968) carried out an incubation study in medium black soil, applied with various levels of organic matter, FYM and nitrogen through ammonium sulphate alone and in combination. Their results showed that, availability of nitrogen increased at 0.5 to 1.0 per cent level of organic matter addition

✓ Sandhu and Meelu (1974) reported that application of FYM with phosphorus and potassium fertilizers significantly increased total nitrogen content of soil.

✓ The use of vermicast and vermicompost was recommended as a super manure or biofertilizer in crop production for maintenance of balanced soil health. The earthworm castings were found rich in ammonia, urea and nitrate (Lee, 1985)

A field experiment was conducted by Gupta *et al* (1988) and found that the application of FYM increased the available nitrogen of soil upto 20 days and decreased thereafter.

Balsaraf (1990) observed that application of FYM, PMC and iron pyrite in black calcareous soil under maize-wheat cropping system significantly increased available nitrogen content of soil over control

✓ The work done at NARP, Ganeshkhind, Pune during 1991-92 revealed that application of vermicompost and FYM increased the available nitrogen content of soil under sapota orchard over control (Anonymous, 1992)

✓ Kale *et al* (1992) reported, a high level of total nitrogen in experimental plot with vermicompost and half the dose of chemical fertilizers as compared to recommended dose

✓ Hapse *et al* (1993) observed that application of vermicompost @ 5 Mg ha⁻¹ in medium black soil for sugarcane crop significantly increased the total nitrogen and available nitrogen content of soil over control

✓ The application of poultry manure, biogas slurry, farm yard manure and vermicompost with 100 per cent level was found on par with 75 and 50 per cent levels of manures. The content of available nitrogen was highest in 100 per cent level of vermicompost as compared to 100 per cent

levels of other manures at the end of two years cycle of maize soybean cropping system (Reddy and Reddy, 1998)

Sahu *et al* (1998) reported that incorporation of vermicompost released more available nitrogen to soil

The available nitrogen content of the soil increased over the initial value under 100 per cent NPK + FYM treatment which was due to higher organic carbon content. The favourable soil conditions under FYM addition might have helped in the mineralization of soil N leading to build up of available K (Santhy *et al.*, 1998)

2.1.2 Phosphorus

The incubation study of medium black soil with various levels of organic matter, FYM and nitrogen through ammonium sulphate alone and in combination increased the availability of phosphorus at 1 to 2 per cent level of organic matter (Naik and Ballal, 1968)

Graff (1974) found $137 \mu\text{g g}^{-1}$ phosphorus in cast and $22 \mu\text{g g}^{-1}$ in surface soil (0-10 cm) in a German pasture. Earthworm that burrows deeply into the mineral strata and return periodically the cast faecal material at the soil surface may facilitate the transport of certain elements from deep to the surface layer of the soil profile. There was abundant evidence that concentration of available phosphorus was higher in earthworm casts than in the surrounding soil. Bhriguvanshi (1988) reported that application of FYM to clay loam and sandy loam soils increased available phosphorus.

Application of FYM to coarse loamy typic Ustochrepts soil under wheat crop increased the available phosphorus content of soil upto 32

days after application of FYM (Gupta *et al.*, 1988). Application of FYM, PMC and iron pyrite to black calcareous soil under maize-wheat cropping system significantly increased the available phosphorus content of soil over control (Balsaraf, 1990)

✓ Krishnamoorthy (1990) reported that the casts of earthworm contain greater amount of extractable inorganic phosphate than underlying soils, casts contain higher phosphatase activity than that occurs in undigested soil, which increase the inorganic phosphorus released by mineralization

Results of work done at NARP, Ganeshkhind, Pune revealed that application of vermicompost and FYM to sapota orchard increased the available phosphorus of soil over control (Anonymous, 1992) Similarly, Hapse *et al.* (1993) reported that application of vermicompost @ 5 Mg ha⁻¹ to medium black soil under sugarcane crop significantly increased available phosphorus content of soil as compared to control.

✓ Incorporation of vermicompost in Vertisol with or without inorganic fertilizers increased the available phosphorus content of soil over control (Jadgar, 1994)

✓ Mathur (1997) reported a significant increase in the available phosphorus status of the soil in plots getting FYM application over rest of the treatments

Waghmare (1997) reported the higher availability of phosphorus in vermicompost treatment at 60th day of incubation period in medium black calcareous and non-calcareous soils.

✓ The application of poultry manure, biogas slurry, farm yard manure and vermicompost with 100 per cent level was found on par with 75 and 50 per cent levels of manures. The content of available P_2O_5 was highest in 100 per cent level of vermicompost as compared to 100 per cent levels of other manures at the end of two year cycle of maize-soybean cropping system (Reddy and Reddy, 1998). Sahu *et al.* (1998) reported that incorporation of vermicompost release more available phosphorus to soil

A build up in the available P status of soil over the initial value occurred in 100 per cent NPK + FYM treatment. The FYM, being a direct source of P, might have also solubilized the native phosphorus in soil through release of various organic acids. The carbon dioxide released during the decomposition of organic matter formed carbonic acid, solubilizing certain primary minerals (Santhy *et al.*, 1998).

2.2 Effect of vermicompost and FYM on enzyme activities

Enzymes play key role in the transformation, recycling and availability of plant nutrients in soil. They are likely to be influenced by fertilizers and manures. But the information on effect of fertilizer and manures on soil enzyme is rather inadequate. Among the soil enzymes, urease, phosphatase and cellulase are the extracellular enzymes secreted mostly by soil micro-organisms. Thus, the amount and activities of these enzymes are related to soil properties and respiratory activity

2.2.1 Acid phosphatase (Orthophosphoric monoester phosphohydrolase : EC 3.1.3.2)

Gupta and Bhardwaj (1990) reported that the concentration of acid phosphatase increased drastically in soils containing organic carbon

between 0.5 to 1.0 and greater than 1.0 per cent. The soils of grassland and forest land showed higher activity of phosphatase than those of the cultivated lands owing to more content of organic carbon and microbial population in the former groups of soils. Krishnamoorthy (1990) reported that the casts of earthworm contain higher phosphatase activity than that occurs in indigested soils.

Perucci (1992) studied the enzyme activity and microbial biomass in a field soil amended with municipal refuse and observed that the addition of compost caused significant increases in the activity of all enzymes tested including acid phosphatase. The increases were much greater at 90 Mg ha⁻¹ yr⁻¹ than at 30 Mg ha⁻¹ yr⁻¹. Significant increases were also observed in the biomass carbon content.

Phosphatase activity of soil increased for three years with the addition of $\cong 270$ Mg ha⁻¹ municipal waste compost to calcareous soil grown with maize crop (Giusquiani *et al*, 1994).

Palaniswami and Sree Ramulu (1994) studied the effect of continuous flow of effluent in a channel on soil enzyme activities of the adjoining fields and observed that the acid phosphatase activities were more in areas closer to the channel than further away from the channel. At this distance there is higher organic matter which might have increased microbial activity.

Diaz *et al* (1995) observed higher phosphatase activity at earing than harvest in the field experiments applied with refuse compost, mineral fertilizer and cow manure. The enzyme activity was positively correlated with carbon and nitrogen content of soil.

The enzyme activity of long term field experiment related to carbon, nitrogen, phosphorus (phosphatase) cycling and peroxidase decomposition in soil showed maximum phosphatase activity in FYM treatment (Singaram and Kamalakumari, 1995)

Lal *et al* (1996) showed that application of flyash reduced considerably acid phosphatase activity in the soil, However, addition of FYM increased the acid phosphatase activity probably due to increase in microbial biomass and substrate as organic P. The acid phosphatase activity attained maximum value at 7 days of incubation and declined thereafter, perhaps due to the higher availability of substrate at that period.

The application of FYM increased the phosphatase enzyme activity and was positively correlated with biomass, nitrogen and phosphorus (Mann *et al* , 1996)

2.2.2 Urease (Urea amidohydrolase : EC 3.5.1.5)

The concentration of urease increased drastically in soils containing organic carbon between 0.5 to 1.0 and greater than 1.0 per cent. The soils of grassland and forest land showed higher activity of urease than those of the cultivated lands owing to more content of organic carbon and microbial population in the former groups of soils (Gupta and Bhardwaj, 1990)

Reddy and Chhonkar (1991) found that urease activity in soil and flood waters increased significantly due to organic matter but decreased with flooding and application of inhibitors

The soil organic matter and clay were mainly responsible for variation in urease activity of soil. Urease activity was positively correlated with organic carbon (Singh *et al.*, 1991).

Perucci (1992) observed that the addition of compost caused significant increase in the activity of all enzymes tested including urease. The increases were much greater at 90 Mg ha⁻¹ yr⁻¹ than at 30 Mg ha⁻¹ yr⁻¹. Significant increases were also observed in the biomass carbon content.

Palaniswami and Sree Ramulu (1994) showed that urease activity was more nearer the channel at 15 m away from the effluent channel and this is confirmed by higher organic matter observed at that distance and this may have increased the microbial activity.

The addition of *Sesbania* and rice straw increased the urease activity over the control (90 mg urea hydrolysed kg⁻¹ hr⁻¹) by more than 2 fold (185 mg urea hydrolysed kg⁻¹ hr⁻¹) in the soil incubated for longer periods. The soil urease activity increased slightly with one day of incubation indicating that some urease had been added with the plant materials. The marked increases in soil urease activity under *Sesbania* and rice straw treated soils incubated for longer periods can be attributed to urease of microbial origin, developed during decomposition of the added residues (Saini *et al.*, 1994).

Soils with compost application rates showed the highest values of urease and urease activity was positively correlated with the total C and N amount in the soil at earing (Diaz *et al.*, 1995). Serra *et al.* (1995) observed that urease activity was stimulated by all compost amendments.

(vermicompost and two classical composts) in laboratory incubation but the increase was only transient

The enzymatic activity of urease was found to be maximum in FYM treatment. Higher rates of NPK fertilization enhanced the activities of soil enzymes and the effect was more pronounced with FYM in combination with NPK fertilizers (Singaram and Kamalakumari, 1995)

Singh *et al.* (1995) observed that urease activity was significantly related to organic carbon content of soil ($r = 0.45^*$) and available nitrogen ($r = 0.49^*$) indicating that urease activity increased with increase in organic carbon content and available nitrogen of soil.

Tiwari and Mishra (1995) observed that the urease activity was higher under forest and natural grassland vegetation and were higher during the rainy, summer season and lower during the winter season. Least activity was observed in April and May. Activity of this enzyme was related to the type of vegetation and quality of organic material incorporated in the soil. Litter under pine forest has more lignin, hemicellulose and cellulose than does the organic matter incorporated into the soil under natural grassland and may explain the small differences in enzyme activity in these two sites.

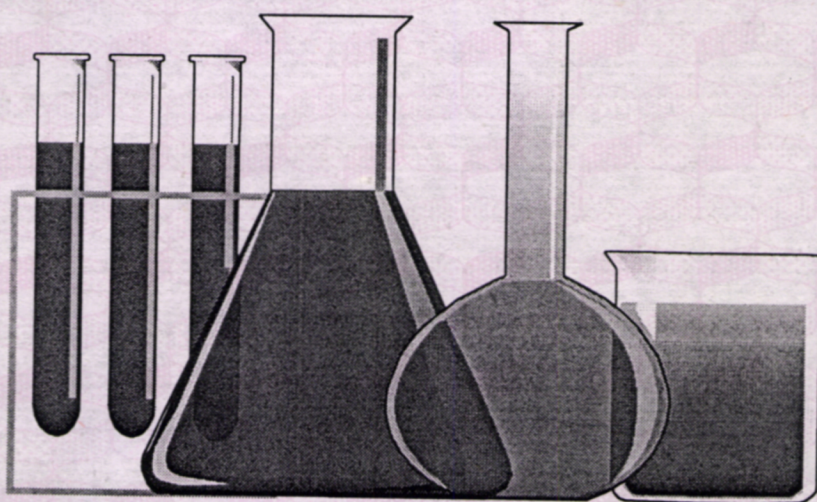
The maximum urease activity was recorded after 7 days of incubation which decreased after 15 days and again increased after 30 days and finally decreased after 45 days. Such variations could largely be due to changes in organic carbon content of soil (Lal *et al.*, 1996)

In general, there was an increase in urease activity with the addition of carbon substrate and declined as the available carbon exhausted.

Urease activity increased significantly with the application of FYM. Application of FYM enhanced build up of microbial biomass and also maintained higher urease activity. The enzyme activity was positively correlated with biomass N and P. There was significant correlation between soil organic carbon and microbial biomass, C, N and urease activity (Mann *et al*, 1996).

Gill *et al* (1998) observed that the nature of organic material added greatly influence the urease activity of soils. The lowest urease activity was recorded in the plot without organic amendment while the highest activity was observed in wheat straw amended combine harvested plots followed by N + FYM plots. This was probably due to very high inherent urease activity (1830 **mg** urea-N hydrolysed $\text{kg}^{-1} \text{hr}^{-1}$) associated with wheat straw.

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**MATERIAL
AND
METHODS**

3. MATERIAL AND METHODS

An incubation study was conducted in natural day light under laboratory conditions at the Department of Agricultural Chemistry and Soil Science, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri during the year 1998-99 to study the effect of vermicompost and FYM on soil enzymes in swell shrink soil. The details of the materials used and methods adopted in the present investigation are given in this chapter.

3.1 Materials

3.1.1 Soil

The soil used for pot culture experiment was medium black, alkaline, calcareous in nature and belonged to Sawargaon series (Vertic Ustropepts). The soil sample (0-15 cm) was collected from the Post Graduate Institute Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri and air dried in the laboratory. The soil was ground in wooden mortar and pestle and sieved through 2 mm sieve. It was then used for incubation study. The important physical and chemical properties of soil were determined by using standard methods (Table 1) and analytical data is reported in (Table 2).

3.1.2 Pots

The plastic bowls of 7 x 17 cm (height x diameter) size were used for incubation study. Each pot was filled with 2 kg of air dried 2 mm sieved soil.

Table 1. Methods of analysis

Sr No	Determination	Method	Reference
I Soil			
1	Particle size analysis	Bouycous hydrometer method	Gee and Bauder (1986)
2	pH	Potentiometry (1.2.5)	Jackson (1973)
3.	EC	Conductometry	Jackson (1973)
4	Organic carbon	Walkley and Black (1934) wet oxidation method	Nelson and Sommer (1982)
5	Total nitrogen	Macro kjeldahl	Bremner (1965)
6	Available nitrogen	Alkaline permanganate method	Subbiah and Asija (1956)
7.	Available phosphorus	Ascorbic acid method	Watanabe and Olsen, (1965)
II. Vermicompost and FYM			
1	Organic carbon	Walkley and Black (1934) wet oxidation method	Nelson and Sommer (1982)
2	Total nitrogen	Macrokjeldahl	Bremner (1965)
3	Total P ₂ O ₅	Colorimetric	Jackson (1973)

Table 2. Physical and chemical properties of soil

Sr No	Soil property	Content
1	Sand (%)	20.45
2	Silt (%)	13.30
3	Clay (%)	66.25
4.	Textural class	Clay
5	Field capacity (%)	44.37
6	Organic carbon (%)	0.47
7	Total N (%)	0.059
8	C.N ratio	7.97
9	pH (1:2.5)	8.7
10	EC (1:2.5) (dS m ⁻¹)	0.18
11	Available N (kg ha ⁻¹)	158
12	Available P (kg ha ⁻¹)	7.38
13	Enzyme activity	
	(i) Acid phosphatase ($\mu\text{M 'P' g}^{-1} \text{ soil hr}^{-1}$)	4.92
	(ii) Urease ($\text{mg NH}_4^+ - \text{N } 100 \text{ g}^{-1} \text{ soil hr}^{-1}$)	21.25

3.1.3 Vermicompost

A well decomposed vermicompost and farm yard manure was obtained from Senior Sorghum Breeder, Sorghum Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri. The vermicompost used for the experiment was analysed for the different constituents and analytical data is given in Table 3

Table 3. Chemical composition of vermicompost and farm yard manure (oven dry basis)

Sr No	Constituent	FYM	Vermicompost
1	Organic carbon (%)	20.8	8.43
2	Total nitrogen (%)	0.79	0.38
3	C/N ratio	26.3	22.18
4	Total P ₂ O ₅ (%)	0.92	0.71

3.2 Experimental Details

3.2.1 Treatment Details

a) Source of organic manure

S₁ = Vermicompost

S₂ = Farm yard manure

b) Levels of vermicompost and FYM

There were six levels of each source :

L₀ – Control (no organic manure)

L₁ – 10 Mg ha⁻¹

L₂ – 20 Mg ha⁻¹

L₃ – 30 Mg ha⁻¹

L ₄	–	40 Mg ha ⁻¹
L ₅	–	50 Mg ha ⁻¹

The twelve treatment combinations were replicated thrice and data obtained was statistically analysed by using Factorial Completely Randomised Design (FCRD)

3.3 Methods

3.3.1 Incubation

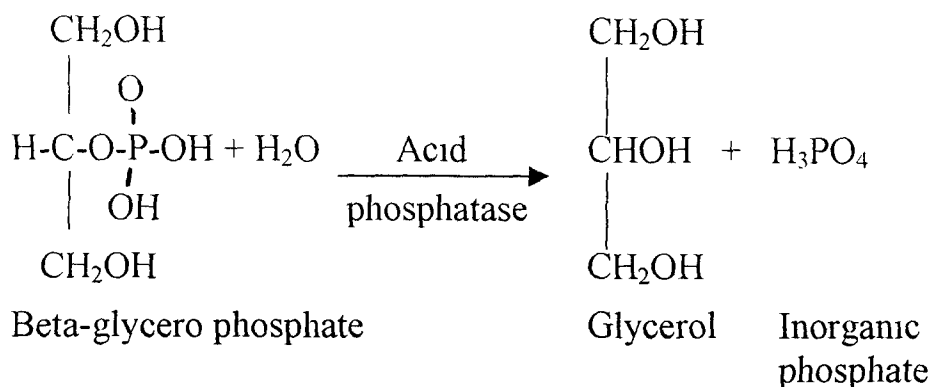
The pots were filled in with 2 kg sieved soil. Vermicompost and FYM were mixed thoroughly as per the treatments. The moisture content was maintained at field capacity during the course of incubation period by adding distilled water on weight basis

3.3.2 Soil analysis

The soil samples were drawn from the pot at an interval of seven days upto 60 days. The samples were analysed for available N, P and enzymes viz , acid phosphatase and urease.

3.3.3 Acid phosphatase enzyme assay

For assay of acid phosphatase enzyme, the extraction was done by the method of Tabatabai and Bremner (1969) and colour development by King (1932)

Reaction :**Reagents :**

1. Modified universal buffer (MUB) stock solution – 12.1 g of tris (hydroxymethyl) aminomethane (THAM), 11.6 g of maleic acid, 14.0 g citric acid and 6.3 g boric acid were dissolved in 488 mL of 1 N NaOH and diluted to 1 L with distilled water
2. Modified universal buffer (MUB), pH 6.5 – 200 mL of MUB stock solution was placed in a 500 mL beaker containing a magnetic stirring bar, and the beaker was placed on a magnetic stirrer. The solution was titrated to pH 6.5 with 0.1 N HCl and the volume adjusted to 1 L with distilled water
3. Na-β-glycerophosphate, 0.1 M – 3.1514 g of Na-β-glycerophosphate was dissolved in about 60 mL of modified universal buffer (MUB) pH 6.5 and the solution diluted to 100 mL with MUB of pH 6.5.
4. Ammonium molybdate, 5 % - 5 g of ammonium molybdate was dissolved in distilled water and the volume made to 100 mL.
5. Perchloric acid, 60 % - 60 mL of perchloric acid was diluted in distilled water and the volume made to 100 mL

- 6 Amino naphthol sulphonic acid (ANSA) – 0.5 g of 1, 2, 4 amino naphthol sulphonic acid, 30 g sodium bisulphite and 60 g sodium sulphite were dissolved in distilled water to make up 250 mL.
- 7 Standard phosphorus solution, 0.01 M – 1.361 g of KH_2PO_4 was dissolved in distilled water to which 10 mL of conc H_2SO_4 was added and the final volume made to 1 L

Method :

Acid phosphatase enzyme was extracted from a known amount of soil by the procedure of Tabatabai and Bremner (1969). Five gram of soil was taken in 50 mL conical flask. In each conical flask 1 mL toluene, 20 mL of modified universal buffer MUB (pH 6.5) and 5 mL of Na- β -glycerophosphate was added. The flasks were incubated in water bath at 37°C for 90 minutes. The flasks were replaced from water bath and kept in boiling water bath for 15 minutes to kill the enzyme activity. The content was filtered. Five mL of this extract was used for colour development.

Colour development :

For colour development the procedure given by King (1932) was used. Five mL of filtrate was pipetted out in clean dry 25 mL volumetric flask to which 1 mL ammonium molybdate, 1.2 mL of perchloric acid and 1 mL of ANSA were added and final volume was made to 25 mL with distilled water for colour development. The absorbance was read on Spectronic-20 at 660 nm after 30 minutes against blank. The amount of inorganic phosphorus produced was calculated from the standard curve and the acid phosphatase activity was expressed in terms of $\mu\text{M 'P' g}^{-1} \text{ soil hr}^{-1}$

Calibration of standard curve :

In a series of 25 mL volumetric flask 0, 0.1, 0.2, 0.3 . . 1 mL of 0.01 M phosphorus solution was pipetted out in triplicates. Rest of the procedure was same as described in the colour development. The standard curve was plotted on a graph paper taking μM of phosphorus concentration values against the absorbance at 660 nm (Fig 1)

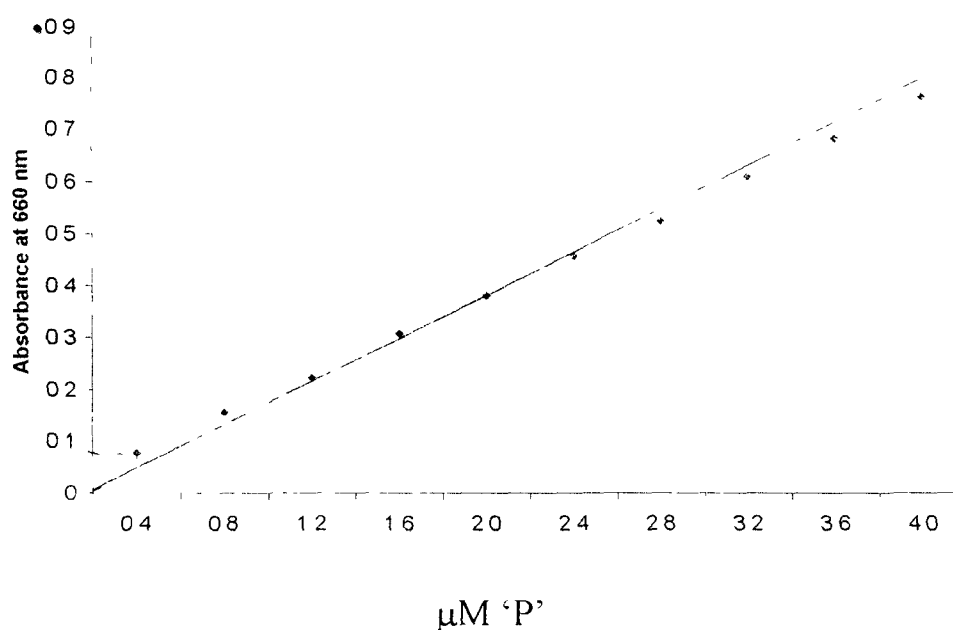
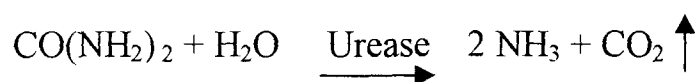


Fig. 1. Standard curve for acid phosphatase assay

Reaction –



Reagents :

- 1 Tris (hydroxymethyl) amino methane (THAM) buffer, 0.05 M, pH 9.0 – Dissolve 6.1 g of THAM was dissolved in about 700 mL of water titrate the pH of the solution to 9.0 by addition of approximately 0.2 M H₂SO₄, and diluted with water to 1 L
- 2 Urea solution, 0.2 M – 1.2 g urea was dissolved in about 80 mL of THAM buffer and the solution was diluted to 100 mL with THAM buffer
- 3 Potassium chloride, 2.5 M – Silver sulphate (100 µg mL⁻¹) (KCl – Ag₂SO₄) solution – 100 mg of reagent grade Ag₂SO₄ was dissolved in about 700 mL of water, 188 g of reagent grade KCl was dissolved in this solution and the solution was diluted to 1 L with distilled water
- 4 Sodium hydroxide, 2.5 % - 2.5 g NaOH was dissolved in distilled water and the volume made to 100 mL.
- 5 Boric acid, 2 % – 20 g of boric acid was dissolved in distilled water and the volume made to 1 L
- 6 Mixed indicator – 0.066 g of methyl red and 0.099 g of bromocresol green were dissolved separately in ethanol and the volume made to 100 mL with ethanol
- 7 Working boric acid solution – 20 mL of mixed indicator was added to 1 L of 2 % boric acid and the pH was adjusted to 5.0

after shaking or addition of 0.1 N NaOH continuously until solution assumed reddish purple tinge or wine red colour

- 8 H₂SO₄ 0.1 N (Stock solution) – 2.80 mL of conc H₂SO₄ was taken and the volume made to 1 L with distilled water
- 9 H₂SO₄ 0.005 N (working solution) – 50 mL of stock solution (H₂SO₄ 0.1 N) was taken and the volume made to 1 L

Method :

Five gram of soil was taken in 50 mL of clean dry conical flask. In each conical flask 0.2 mL of toluene and 9 mL of THAM buffer was added. The conical flasks were incubated in water bath for 2 hours at 37°C. The conical flasks were replaced from the water bath and approximately 35 mL of potassium chloride - silver sulphate solution (KCl-Ag₂SO₄) was added. The content was shaken for few seconds and diluted to 50 mL in volumetric flask with KCl-Ag₂SO₄ solution. The volumetric flasks were inverted several times and allowed to settle. Twenty millilitres of supernatant liquid was used for ammonical nitrogen (NH₄-N) estimation by microkjeldahl method.

3.3.4 Urease enzyme assay

The urease enzyme assay was carried out according to the method described by Tabatabai and Bremner (1972).

3.3.5 Statistical Analysis

The data obtained in different observations were processed statistically by using Factorial Completely Randomised Block Design as described by Panse and Sukhatme (1967).

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**RESULTS AND
DISCUSSION**

4. RESULTS AND DISCUSSION

The investigation was undertaken under laboratory conditions with six levels each of vermicompost and farm yard manure to study the effect of vermicompost and FYM on soil enzymes in swell shrink soil during 1998-1999. The results obtained are presented and discussed as under

4.1 Effect of vermicompost and FYM on available nitrogen ($\text{mg } 100 \text{ g}^{-1}$ soil) in soil

Effect of vermicompost and farm yard manure on available nitrogen in soil are reported in Table 4 and presented in Fig. 2. The data indicated that the application of vermicompost, FYM and their levels of application and interactions showed significant effect on availability of nitrogen in soil throughout during incubation period.

The application of vermicompost was found significantly superior in increasing the availability of nitrogen over farm yard manure throughout incubation period. The increased availability of soil nitrogen in soil over a period of time due to vermicompost than FYM might be due to complete decomposition of organic matter by the earthworm. Similarly, during the preparation of vermicompost the cast contains organic acids, hormones and also the micro-organism that stimulates the microbial activity in soil as result increased the availability of nitrogen in soil

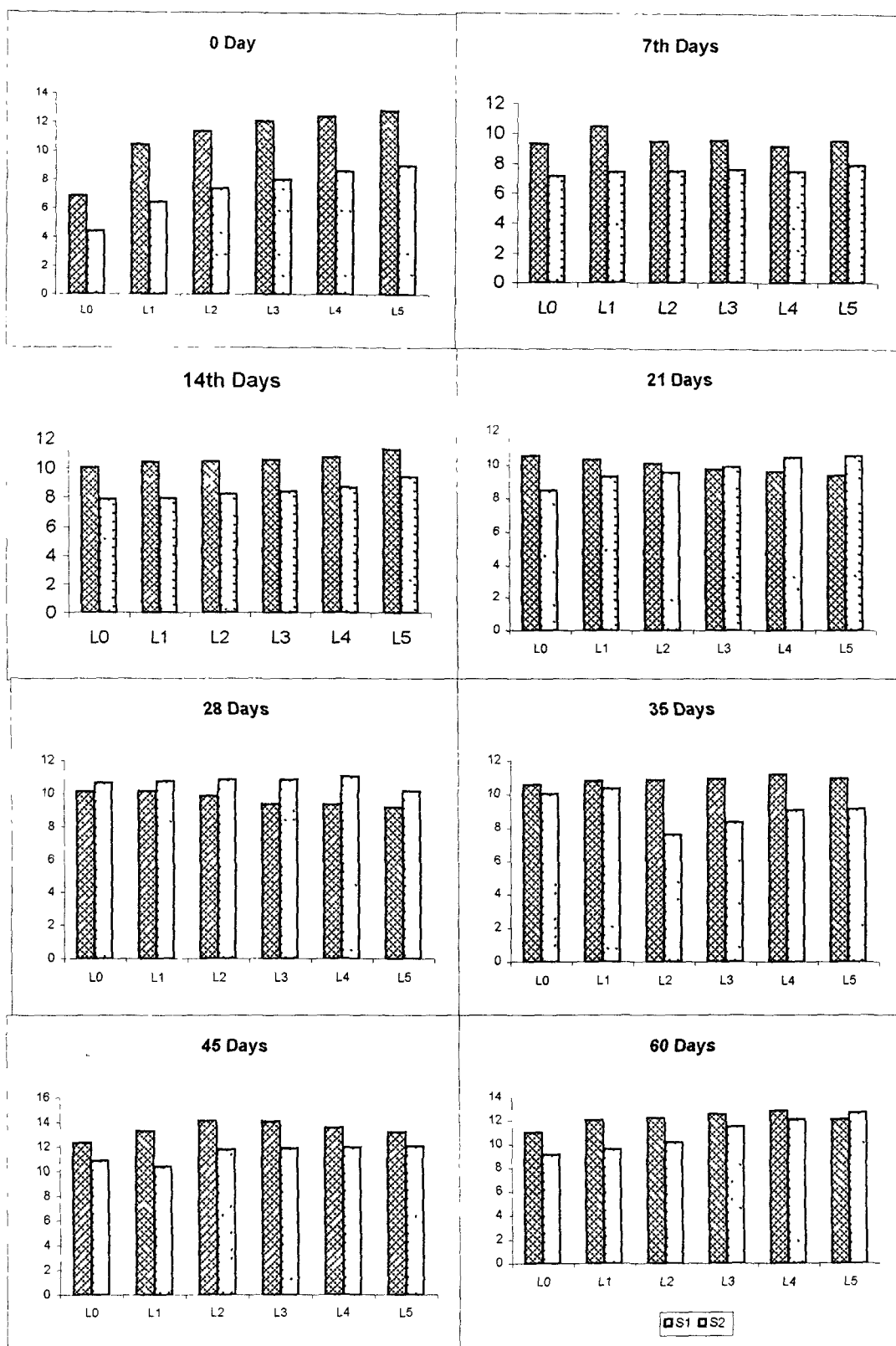
The increased levels of organic manure significantly increased the available nitrogen content in soil. However, the interaction effect of levels of organic manures and their sources were found significant over the control throughout incubation period. The highest levels of organic manure

Table 4. Effect of vermicompost and FYM on available nitrogen (mg 100 g⁻¹ soil) in soil

Organic manure levels	S1	S2	Mean	Source	S.E. ±	C.D. at 5%
0 Days						
L0	6.87	4.41	5.64	S	0.048	0.138
L1	10.45	6.46	8.45	L	0.083	0.238
L2	11.41	7.39	9.40	S x L	0.118	0.329
L3	12.10	8.05	10.07			
L4	12.44	8.65	10.54			
L5	12.85	9.06	10.95			
Mean	8.87	7.33	-			
7 Days						
L0	9.31	7.14	8.22	S	0.046	0.131
L1	10.47	7.46	8.96	L	0.079	0.227
L2	9.50	7.53	8.51	S x L	0.112	0.322
L3	9.58	7.61	8.59			
L4	9.20	7.51	8.35			
L5	9.57	7.94	8.75			
Mean	9.44	7.53	-			
14 Days						
L0	10.04	7.85	8.94	S	0.029	0.083
L1	10.46	7.93	9.19	L	0.050	0.144
L2	10.50	8.24	9.37	S x L	0.071	0.204
L3	10.59	8.42	9.50			
L4	10.80	8.71	9.75			
L5	11.32	9.46	10.39			
Mean	10.62	8.43	-			
21 Days						
L0	10.55	8.50	9.52	S	0.042	0.120
L1	10.33	9.32	9.82	L	0.073	0.208
L2	10.12	9.57	9.84	S x L	0.103	0.294
L3	9.78	9.92	9.85			
L4	9.63	10.49	10.06			
L5	9.43	10.60	10.01			
Mean	9.97	9.73	-			

Table 4. Contd

Organic manure levels	S1	S2	Mean	Source	S.E. \pm	C.D. at 5%
28 Days						
L0	10 15	10 66	10 40	S	0 031	0 089
L1	10 16	10 76	10 45	L	0 054	0 155
L2	9 89	10 85	10 37	S x L	0 076	0 219
L3	9 40	10 84	10 12			
L4	9 34	11 04	10 19			
L5	9 19	10 18	10 18			
Mean	9 69	10 89				
35 Days						
L0	10 59	10 03	10 31	S	0 063	0 180
L1	10 81	10 37	10 59	L	0 109	0 311
L2	10 86	7 62	9 24	S x L	0 154	0 441
L3	10 94	8 37	9 65			
L4	11 18	9 08	10 26			
L5	10 97	9 129				
Mean						
45 Days						
L0	12 33	10 87	11 60	S	0 055	0 158
L1	13 31	10 36	11 83	L	0 096	0 274
L2	14 13	11 75	12 94	S x L	0 135	0 387
L3	14 09	11 88	12 90			
L4	13 58	11 95	12 76			
L5	13 23	12 04	12 63			
Mean	13 44	11 64				
60 Days						
L0	11 03	9 11	10 07	S	0 043	0 125
L1	12 04	9 56	10 8	L	0 076	0 217
L2	12 24	10 18	11 21	S x L	0 107	0 307
L3	12 54	11 52	12 03			
L4	12 86	12 11	12 48			
L5	12 10	12 71	12 90			
Mean	12 30	10 86				



X = Levels of vermicompost and FYM, Y = Available 'N' (mg 100 g⁻¹ soil)
Fig 2. Effect of vermicompost and FYM on available nitrogen in soil

found significantly superior over its lower levels of organic manure application. The successive increase in levels of organic manure application were found at par with its lower levels of organic manure application.

✓ In general, the application of vermicompost found significantly beneficial over farm yard manure application and the higher levels of organic manure showed significant effect over their lower levels for increasing the availability of nitrogen in soil. Similar observations were also recorded by Reddy and Reddy (1998) and Sahu *et al* (1998). The increased content of nitrogen in soil might be due to addition of organic matter to soil, which increases the microbial population and soil enzymatic activity.

4.2 Effect of vermicompost and FYM on available phosphorus (mg 100 g⁻¹ soil) in soil

The data reported in Table 5 and depicted in Fig 3, revealed that, the application of vermicompost significantly increases the available phosphorus in soil over farm yard manure. It was maximum at 14th day of incubation and thereafter it was reduced with an advanced incubation period. However, the availability of phosphorus in soil may increase with an increase in incubation period. However, the concentration and amount of organic acid will be decreased with the increase in incubation period. As a result, at later stages of incubation the availability of phosphorus in soil was decreased. Similar observations were recorded by Jadgar (1994) and Reddy and Reddy (1998).

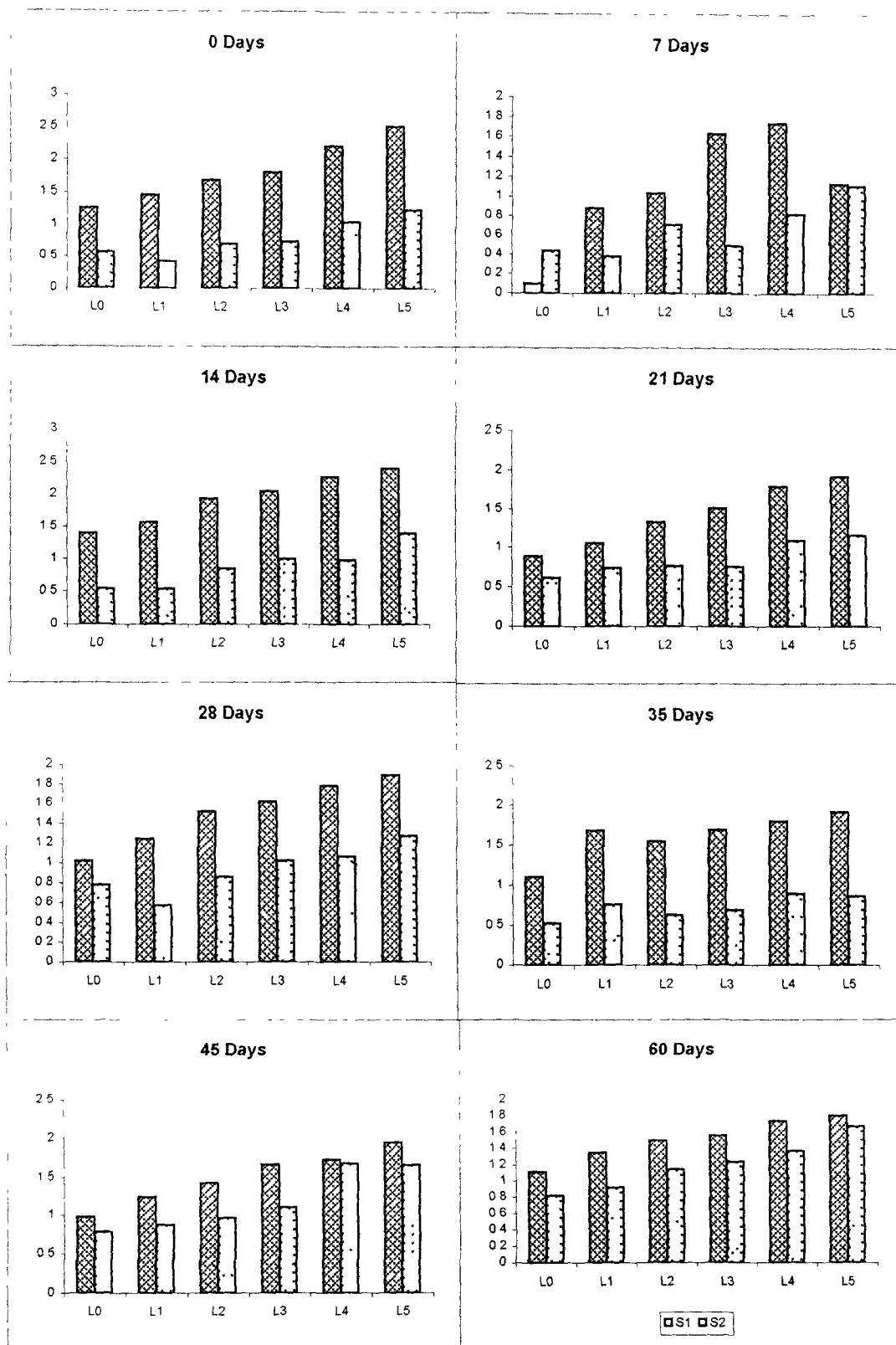
The availability of phosphorus in soil was significantly increased with an increased incubation period due to farm yard manure application. The reduced availability of phosphorus in soil at earlier incubation period might be due to partially decomposed FYM. During the

Table 5. Effect of vermicompost and FYM on available phosphorus (mg 100 g⁻¹ soil) in soil

Organic manure levels	S1	S2	Mean	Source	S.E. ±	C.D. at 5%
0 Days						
L0	1.26	0.57	0.91	S	0.038	0.111
L1	1.47	0.42	0.94	L	0.067	0.192
L2	1.69	0.70	1.19	S x L	0.095	0.272
L3	1.81	0.73	1.27			
L4	2.22	1.05	1.63			
L5	2.52	1.24	1.88			
Mean	1.83	0.78				
7 Days						
L0	0.10	0.44	0.57	S	0.039	0.111
L1	0.88	0.38	0.63	L	0.067	0.193
L2	1.03	0.71	0.87	S x L	0.095	0.273
L3	1.63	0.49	1.06			
L4	1.74	0.82	1.28			
L5	1.13	1.11	1.12			
Mean	1.18	0.66				
14 Days						
L0	1.40	0.54	0.97	S	0.024	0.070
L1	1.57	0.54	1.05	L	0.042	0.121
L2	1.94	0.85	1.40	S x L	0.060	0.171
L3	2.05	1.00	1.52			
L4	2.28	0.98	1.63			
L5	2.41	1.40	1.91			
Mean	1.94	0.88				
21 Days						
L0	0.89	0.62	0.76	S	0.032	0.092
L1	1.06	0.74	0.90	L	0.056	0.160
L2	1.33	0.77	1.04	S x L	0.079	0.226
L3	1.51	0.76	1.13			
L4	1.79	1.09	1.44			
L5	1.92	1.16	1.54			
Mean	1.42	1.85				

Table 5. Contd

Organic manure levels	S1	S2	Mean	Source	S.E. ±	C.D. at 5%
28 Days						
L0	1.02	0.78	0.90	S	0.026	0.074
L1	1.24	0.57	0.91	L	0.045	0.129
L2	1.52	0.86	1.19	S x L	0.064	0.183
L3	1.62	1.02	1.32			
L4	1.78	1.06	1.42			
L5	1.89	1.27	1.58			
Mean	1.51	0.93				
35 Days						
L0	1.11	0.53	0.82	S	0.031	0.091
L1	1.68	0.76	1.22	L	0.055	0.158
L2	1.55	0.63	1.09	S x L	0.078	N S
L3	1.69	0.69	1.19			
L4	1.80	0.89	1.34			
L5	1.91	0.86	1.38			
Mean	1.62	0.72				
45 Days						
L0	0.98	0.79	0.88	S	0.023	0.066
L1	1.24	0.88	1.06	L	0.040	0.115
L2	1.42	0.96	1.19	S x L	0.057	0.163*
L3	1.66	1.10	1.38			
L4	1.72	1.67	1.70			
L5	1.94	1.65	1.80			
Mean	1.49	1.17				
60 Days						
L0	1.11	0.82	0.96	S	0.021	0.060
L1	1.35	0.92	1.13	L	0.036	0.105
L2	1.50	1.14	1.32	S x L	0.051	N S (0.148)
L3	1.56	1.24	1.35			
L4	1.74	1.37	1.55			
L5	1.80	1.67	1.73			
Mean	1.51	1.19				



X = Levels of vermicompost and FYM, Y = Available 'P' (mg 100 g⁻¹ soil)

Fig. 3. Effect of vermicompost and FYM on avail. phosphorus in soil

course of incubation period the FYM was completely decomposed producing organic acids as well as increased the microbial population in soil which may increase the phosphorus availability in soil at later incubation periods. Similar observation was observed by Bhriguvanshi (1998)

The interaction effect of levels and sources of organic manure application was found to be significant in increasing the availability of phosphorus in soil. The interaction effect was more pronounced at higher levels over a lower levels at all the incubation period. Whereas, interaction effect at 40 and 50 Mg ha⁻¹ application of organic sources were found at par with each other at every incubation period.

4.3 Effect of vermicompost and FYM on activity of acid phosphatase in soil

The data presented in Table 6 and Fig. 4, revealed that the activity of acid phosphatase enzyme was significantly increased with addition of vermicompost over farm yard manure throughout the incubation period. The activity of acid phosphatase in soil was increased with an increase in levels of organic manure.

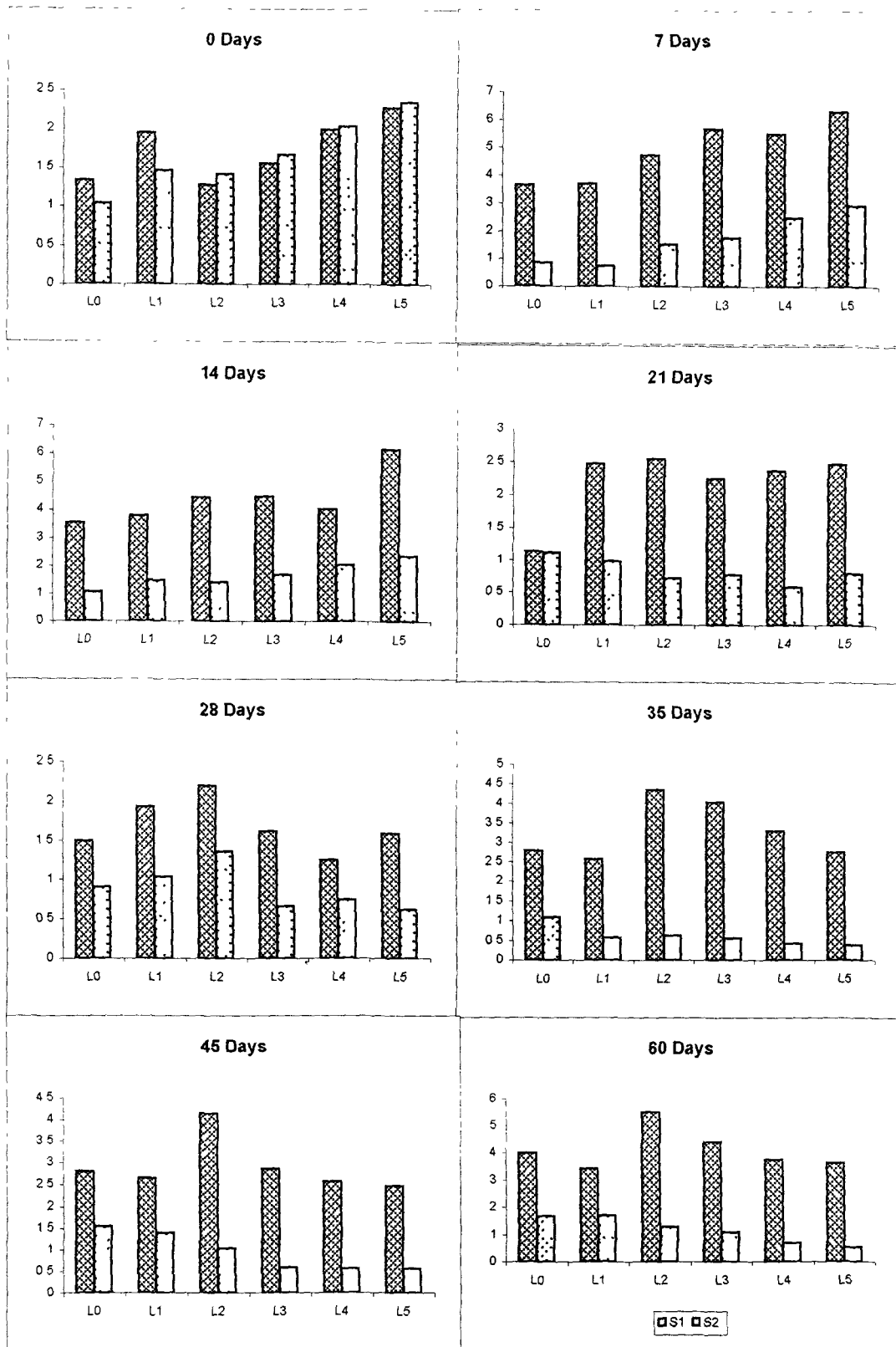
The activity of acid phosphatase enzyme in soil was found more up to the 14th days of incubation period. However, it was declined with the increase in incubation period up to 45th days due to higher availability of substrate at that period and increased at 60th days of incubation. This was might be due to the fixation of phosphorus with clay particles

Table 6. Effect of vermicompost and FYM on activity of acid phosphatase ($\mu\text{M 'p' g}^{-1} \text{ soil hr}^{-1}$) in soil

Organic manure levels	S1	S2	Mean	Source	S.E. \pm	C.D. at 5%
0 Days						
L0	1.34	1.04	1.19	S	0.188	0.538
L1	1.95	1.46	1.70	L	0.326	0.932
L2	1.28	1.42	1.35	S x L	0.461	1.31
L3	1.56	1.67	1.61			
L4	2.00	2.04	2.02			
L5	2.29	2.36	2.32			
Mean	1.73	1.66				
7 Days						
L0	3.64	0.87	2.26	S	0.050	0.143
L1	3.71	0.75	2.23	L	0.086	0.248
L2	4.76	1.56	3.16	S x L	0.122	0.350
L3	5.71	1.79	3.75			
L4	5.52	2.53	4.03			
L5	6.35	2.97	4.66			
Mean	4.95	1.75				
14 Days						
L0	3.55	1.04	2.30	S	0.178	0.510
L1	3.79	1.46	2.62	L	0.309	0.844
L2	4.44	1.42	2.93	S x L	0.437	N S
L3	4.49	1.67	3.08			
L4	4.05	2.04	3.04			
L5	6.16	2.36	4.26			
Mean	4.41	1.66				
21 Days						
L0	1.13	1.11	1.12	S	0.057	0.164
L1	2.48	0.98	1.73	L	0.100	0.285
L2	2.55	0.72	1.63	S x L	0.141	0.404
L3	2.26	0.78	1.49			
L4	2.38	0.58	1.48			
L5	2.48	0.79	1.63			
Mean	2.21	0.83				

Table 6. Contd....

Organic manure levels	S1	S2	Mean	Source	S.E. ±	C.D. at 5%
28 Days						
L0	1 50	0 91	1 20	S	0 062	0 179
L1	1 93	1 04	1 01	L	0 108	0 310
L2	2 20	1 36	1 78	S x L	0 153	N S
L3	1 62	0 66	1 14			
L4	1 25	0 74	0 99			
L5	1 59	0 62	1 10			
Mean	1 68	0 89				
35 Days						
L0	2 79	1 10	1 94	S	0 321	0 917
L1	2 57	0 58	1 57	L	0 556	N S
L2	4 35	0 63	2 49	S x L	0 786	N S
L3	4 04	0 56	2 30			
L4	3 29	0 43	1 86			
L5	2 75	0 39	1 57			
Mean	3 30	0 62				
45 Days						
L0	2 80	1 55	2 17	S	0 322	0 921
L1	2 65	1 40	2 03	L	0 558	N S
L2	4 14	1 04	2 59	S x L	0 790	N S
L3	2 86	0 59	1 73			
L4	2 57	0 56	1 56			
L5	2 47	0 56	1 52			
Mean	2 91	0 95				
60 Days						
L0	4 00	1 69	2 84	S	0 403	1 15
L1	3 41	1 71	2 56	L	0 698	N S
L2	5 50	1 30	3 40	S x L	0 987	N S
L3	4 40	1 10	2 75			
L4	3 74	0 70	2 22			
L5	3 62	0 53	2 07			
Mean	4 11	1 16				



X = Levels of vermicompost and FYM, Y = 'A P' activity ($\mu\text{M 'p' g}^{-1} \text{ soil hr}^{-1}$)
Fig. 4. Effect of vermicompost and FYM on activity of acid phosphatase enzyme in soil

The interaction effect of organic manure source and levels were found statistically significant for acid phosphatase activity in soil throughout the incubation period except 14th days of incubation.

In general, the increase in the activity of acid phosphatase enzyme in soil was might be due to increase in microbial biomass, organic phosphorus as substrate, organic carbon and nitrogen content of soil. Increase in activity of acid phosphatase upon organic matter addition was also found by Diaz *et al* (1995) and Lal *et al* (1996)

4.4 Effect of vermicompost and FYM on urease enzyme in soil

The data given in Table 7 and Fig 5 indicated that the addition of vermicompost and FYM were increased the activity of urease enzyme in soil over control throughout the incubation period. However, application of vermicompost was found significantly superior over farm yard manure throughout the incubation period.

The soil urease activity was increased with the increase in levels of vermicompost and farm yard manure. The levels of vermicompost application was showed higher urease activity over the levels of farm yard manure application up to 21st days of an incubation.

The interaction effect of levels and organic manure were found to be significant in all the incubation period except 7th days of incubation

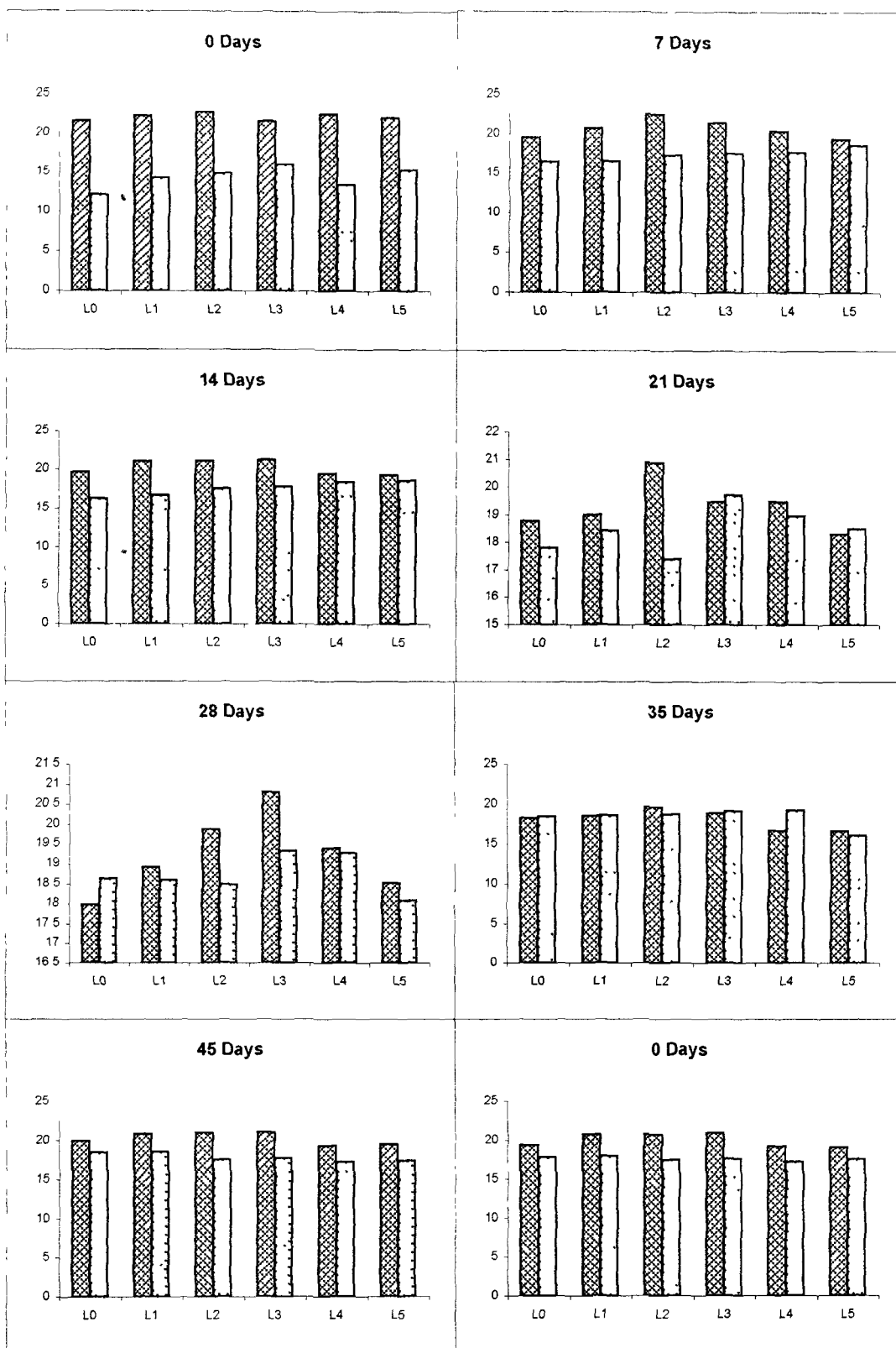
It is generally, assumed that the urease in soil is essentially a microbial extracellular enzyme accumulated through release of urease from living and disintegrated microbial cells. Soil contains urease producing microorganism which helps in increasing the urease activity. Their

Table 7. Effect of vermicompost and FYM on activity of urease enzyme (mg NH₄-N 100 g⁻¹ soil hr⁻¹) in soil

Organic manure levels	S1	S2	Mean	Source	S.E. ±	C.D. at 5%
0 Days						
L0	21 63	12 16	16 89	S	0 128	0 367
L1	22 28	14 35	18 31	L	0 222	0 636
L2	22 77	14 91	18 84	S x L	0 315	0 900
L3	21 62	16 09	18 85			
L4	22 57	13 47	18 02			
L5	22 11	15 40	18 75			
Mean	21 50	14 40				
7 Days						
L0	19 58	16 48	18 03	S	0 261	0 745
L1	20 78	16 53	18 65	L	0 452	1 29
L2	22 57	17 34	19 95	S x L	0 639	N S
L3	21 54	17 66	19 60			
L4	20 44	17 74	19 09			
L5	19 47	18 71	18 59			
Mean	20 73	16 91				
14 Days						
L0	19 64	16 31	19 47	S	0 201	0 576
L1	21 06	16 72	18 89	L	0 349	0 997
L2	21 13	17 56	19 84	S x L	0 494	1 410
L3	21 30	17 82	19 56			
L4	19 51	18 41	18 96			
L5	19 28	18 63	18 45			
Mean	20 49	17 07				
21 Days						
L0	18 77	17 82	18 29	S	0 164	0 463
L1	19 02	18 45	18 72	L	0 284	0 812
L2	20 87	17 42	19 41	S x L	0 402	1 140
L3	19 48	19 72	19 60			
L4	19 49	18 97	19 22			
L5	18 32	18 52	18 92			
Mean	19 32	17 65				

Table 7. Contd

Organic manure levels	S1	S2	Mean	Source	S.E. \pm	C.D. at 5%
28 Days						
L0	17 97	18 63	18 30	S	0 234	0 671
L1	18 92	18 59	18 75	L	0 406	1 160
L2	19 88	18 48	19 18	S x L	0 575	1 640
L3	20 80	19 33	20 06			
L4	19 40	19 27	19 33			
L5	18 52	18 08	18 80			
Mean	19 25	18 23				
35 Days						
L0	18 34	18 52	18 43	S	0 102	0 291
L1	18 56	18 62	18 59	L	0 176	0 505
L2	19 66	18 80	19 23	S x L	0.250	0 714
L3	18 90	19 20	19 05			
L4	16 72	19 24	17 98			
L5	16 70	16 15	15 92			
Mean	18 15	17 92				
45 Days						
L0	19 94	18 46	19 20	S	0 312	0 892
L1	20 89	18 50	19 69	L	0 541	N S
L2	21 02	17 47	19 24	S x L	0 765	N S
L3	21 07	17 71	19 39			
L4	19 31	17 24	18 51			
L5	19 52	17 35	18 43			
Mean	20 29	17 79				
60 Days						
L0	19 36	17 76	18 53	S	0 283	0 810
L1	20 75	17 88	19 31	L	0 491	N S
L2	20 76	17 39	18 07	S x L	0 694	N S
L3	20 92	17 56	19 24			
L4	19 18	17 13	18 15			
L5	19 01	17 46	18 23			
Mean	19 99	17 53				



X = Levels of vermicompost and FYM, Y = Urease activity ($\text{mg NH}_4\text{-N } 100 \text{ g}^{-1} \text{ soil hr}^{-1}$)

Fig. 5. Effect of vermicompost and FYM on activity of urease enzyme in soil

microbial population increases with the addition of organic manures in soil. An increased urease activity upon addition of organic matter was recorded by Serra *et al.* (1995), Lal *et al.* (1996).

Correlation Studies :

The values of coefficient of correlation influenced by application of vermicompost and farm yard manure presented in Table 8 indicated that there was significant positive correlation (+0.371*) between soil available phosphorus and acid phosphatase enzyme. Whereas, urease enzyme activity showed significant positive correlation with acid phosphatase enzyme ($r = +0.592^*$) due to vermicompost application.

The available nitrogen was positively correlated with available phosphorus (+0.679*) and negatively correlated with acid phosphatase enzyme activity (-0.389*) due to farm yard manure application.

From the study, it is clear that the application of vermicompost and FYM significantly enhanced the available nitrogen and phosphorus. Similarly, the activity of acid phosphatase and urease was also increased significantly in soil. From the research work it is also cleared that further investigation in field condition is needed.

Table 8. Influence of vermicompost and FYM on correlation coefficients among the available nitrogen, available phosphorus, urease and acid phosphatase enzyme

	Vermicompost				FYM			
	N	P	Urease	Acid Phosphatase	N	P	Urease	Acid Phosphatase
N	-	+0.262	+0.100	+0.148	-	+0.679*	-0.133	-0.389*
P	-	-	+0.074	+0.371*	-	-	-0.419*	-0.054
Urease	-	-	-	+0.592*	-	-	-	-0.070

N = 22

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SUMMARY
AND
CONCLUSIONS

5. SUMMARY AND CONCLUSION

An incubation study was conducted under laboratory conditions at the Department of Agricultural chemistry and soil science, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri during the year 1999-2000 with six levels each of vermicompost and farm yard manure to study the effect of levels of vermicompost and farm yard manure on soil enzymes in swell shrink soil. The summary and conclusion of the results emerged out of the research work are presented in this chapter.

5.1 Effect of vermicompost and FYM on available nitrogen content in soil

The application of vermicompost and farm yard manure significantly enhanced the nitrogen content in soil over control throughout the incubation period. The higher levels of vermicompost and farm yard manure application @ 40 and 50 Mg ha⁻¹ found significantly superior over the lower levels i.e. 10, 20 and 30 Mg ha⁻¹, respectively.

5.2 Effect of vermicompost and FYM on available Phosphorus content in soil

The available phosphorus content in soil increased significantly over control with increasing levels of vermicompost and farm yard manure. The vermicompost application significantly increased the phosphorus status of soil over farm yard manure application. The interaction effect of organic manure source and levels were significant for available phosphorus, recording the highest value of 2.28 for S₁L₄ on 14th day of incubation.

5.3 Effect of vermicompost and farm yard manure on activity of acid phosphatase enzyme in soil.

The activity of acid phosphatase enzyme was increased with levels of vermicompost and farm yard manure. The acid phosphatase activity was then declined up to 45th days of incubation and again increased at 60th days of incubation.

5.4 Effect of vermicompost and FYM on activity of urease enzyme in soil.

The addition of vermicompost and FYM increased the activity of urease enzyme in soil throughout the period of incubation. Whereas, application of vermicompost found beneficial over farm yard manure application. The increased levels of vermicompost and farm yard manure was found beneficial over lower levels.

5.5 Correlation studies

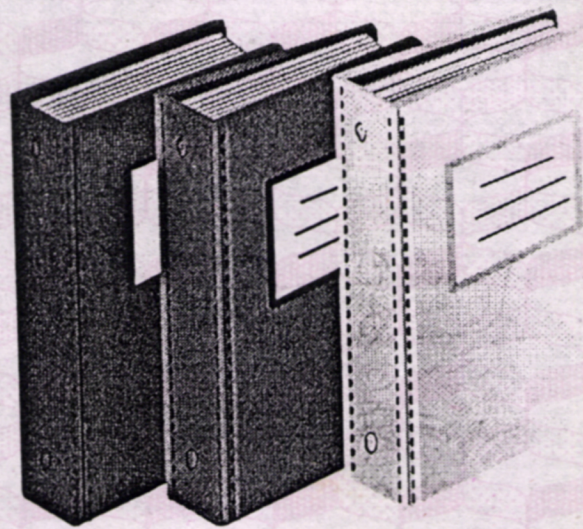
The available phosphorus and acid phosphatase enzyme showed positive correlation (+0.371*). Urease and acid phosphatase enzyme showed significantly positive (+0.592*) correlation due to vermicompost application.

The available nitrogen showed significantly positive (+0.679*) correlation with available phosphorus due to FYM application and negative correlation with acid phosphatase enzyme activity (-0.389*).

Conclusions :

- There was increase in available nitrogen in soil with vermicompost and farm yard manure application
- Available phosphorus increased with vermicompost and farm yard manure application.
- The soil enzymes (acid phosphatase and urease) increased significantly with vermicompost and farm yard manure
- Acid phosphate enzyme was found to be positively correlated with available phosphorus and negatively correlated with urease in vermicompost application
- The soil available nitrogen was found negatively correlated with acid phosphatase and positively correlated with available phosphorus due to farm yard manure application.

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6. LITERATURE CITED

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VITA[®]

7. V I T A

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