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Full Length Research

Effect of Individual and Combined Application of Biofertilizers, Vermicompost and Inorganic Fertilizers on Soil Enzymes and Minerals during the Post Harvesting stage of Chilli (NS 1701)

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Soil microbes have direct beneficial effects on crop production as biofertilizers, (ie) living organisms used in the fertilization of soil. They are useful in supplementing the usual application of nitrogen fertilizers and help in enriching the soil. By providing several nutrients and sufficient organic matter biofertilizers can also be used as a possible tool to reclaim saline or alkaline soil because of their ameliorating effect on the physico-chemical properties of the soil. Indian soils have been chronically poor in nitrogen and phosphorus due to continuous cereal cropping. Correlating soil tests with yields and developing fertilizer recommendations based on extensive experimentation, the levels of NPK are adjusted for specific yield targets. The bioregulation of growth and yield by extremely supplied chemicals are effective in several crops to balance the source sink rate for increasing the yield. Hence a study was undertaken on the "Effect of individual and combined application biofertilizers, vermicompost and inorganic fertilizers on soil enzymes and minerals during the post harvesting stage of Chilli (NS 1701)".

Key words: Chilli, Enzymes, Minerals, Biofertilizers, Vermicompost.

INTRODUCTION

"Fortunately, soil is a dynamic and living entity that has a remarkable resilence to bounce back and restore most of its ecological functions after being disturbed by anthropogenic interventions" (Raman, 2005). Soil enzymes play an important role in mobilising the soil available nutrients to plant available form (Bama *et al*., 2005). Enzyme activities are very much influenced by the addition of organic manures. The enzyme activity is considered as an index of microbial activity. The soil management practices that influence the microbial populations are expected to cause changes in the soil enzyme activity (Prasad *et al*., 2005). Inorganic nitrogen fertilization had a significant effect on soil pH. Application of 60kg N ha^{-1} has enhanced the pH to the maximum. The higher available soil nitrogen has aided rapid mineralization of residue with concomitant release of exchangeable cations to increase the soil pH (Adeboye *et al*., 2006).

Phosphorus can be termed as "life mineral" because of its crucial role in metabolic and energy transfer reactions in living system. Phosphorus is immobile in the soil system and hardly 15 - 20 per cent of the applied phosphorus is utilized by a crop to which it is applied. While the rest remains in a "Fixed" state in soil being influenced by various physico-chemical and biological mechanisms (Raju *et al.,* 2005). Potassium is the third major nutrient after nitrogen and phosphorus required for the buildup of biomass in plants. Added potassium is transferred into the fixed form, which is not readily

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available to the plants but it is not the total loss of potassium as it is added to the reserve pool of soil (Kaur and Benipal, 2005). Distribution of potassium in soils is dependent on its fixation and release. Potassium is initially soluble and exchangeable but has become entrapped in non-exchangeable form in the lattice of mineral crystal such as vermiculite and weathered mica is called potassium fixation (Sparks, 2001).

Biofertilizers are ready to use live formulates of beneficial micro organism which on application to seed, root or soil mobilize the availability of nutrients from non usable form to usable form through biological processes and these groups of microorganisms may either fix atmospheric nitrogen or solubilize insoluble phosphorus and make them available for crops. Biological nitrogen fixation is the reduction of atmospheric nitrogen to ammonia by the microorganism in the soil. The conversion of inert nitrogen is facilitated by the enzyme nitrogenase which is essential for symbiotic nitrogen fixation is present in the nitrogen fixing microorganisms which are marked with nif genes. The enzyme nitrogenase is responsible for converting inert nitrogen to plant usable ammonia (Gupta, 2003). Biofertilizers increases the physico-chemical properties of soils such as soil structure, texture, water holding capacity, cation exchange capacity and pH (Dubey, 2004). *Azospirillum* produces vitamins and antibacterial, antifungal substances, it helps in better seed germination and proliferation of root system thereby playing an important role in developing and establishment of an effective integrated nutrient management system (Singh *et al.,* 2006). It enhances the mineral and water uptake, root development, vegetative growth and crop yield from 15 - 30 per cent. Hormonal effects are the main mechanism in the plant growth promotion by *Azospirillum* (Sathe, 2004).

Composting is a biological aerobic decomposition of organic residues in which liable organic matter is degraded to CO_2 H_2O, NH_3, inorganic nutrients and stable organic material containing humic like substances (Ramos *et al.*, 2005).Certain species of earthworms can rapidly fragment organic material residuals into much finer particles by passing them through a grinding gizzard, an organ that all anellidae possess (Ndegwa and Thompson, 2001). Earthworms reduce the number of pathogens and the same effect is obtained in traditional composting by the increase in temperature (Elvira *et al.*, 1996). Vermicompost contains beneficial soil microorganisms that produce plant growth factors like vitamins and hormones and antibiotics (Lourduraj 2006). Vermicastings have immobilized enzymes like protease, lipase, amylase, cellulase, lichenase and chitinase, which enhances the biodegradation of macromolecules of the agricultural resides in the soil so that further microbial attack is speeded up (Gupta, 2003).

METHODOLOGY

The following experimental procedures were employed to identify "Effect of individual and combined application biofertilizers, vermicompost and inorganic fertilizers on soil enzymes and minerals during the post harvesting stage of Chilli (NS 1701)". The experimental procedures were discussed under the following headings.

A pot culture experiment was laid out in Completely Randomized Design (CRD) and each treatment was replicated for four times. Each pot was uniformly filled with 7.5 kg of soil and treated with different combinations of *Azospirillum, Phosphobacteria*, Triple - 17 complex (N, P and K) and Vermicompost.

The experimental procedures were discussed under the following headings.

1. Preparation of the soil
2. Collection of biofertilizers and vermicompost
3. Sample used
4. Pot culture lay-out and treatment
5. Sowing seeds and maintenance of the crop
6. Soil and vermicompost analysis
7. Statistical analysis

Preparation of the Soil

Each pot was filled with 7.5kg of red soil. The soil was mixed with different combinations of Biofertilizers (*Azospirillum* and *Phosphobacteria*), Inorganic fertilizer (Triple -17 complex), and vermicompost. Triple - 17 complex, *Azospirillum*, *Phosphobacteria* and Vermicompost were added at the rate of 20 gm and 1kg respectively per 10 kg of soil.

Collection of Biofertilizers and Vermicompost

Biofertilizers (*Azospirillum* and *Phosphobacteria*), and vermicompost were collected from Tamil Nadu Agricultural University, Coimbatore.

Triple - 17 Complex

Triple –17 complex was purchased from Agro services, Coimbatore.

Sample used

Chilli seeds of variety Namdhari Seeds-1701 were collected from Agro services, Coimbatore.

Pot Culture Lay-Out and Treatment

The pot culture study was carried out with four replications for each treatment. The treatment were as follows.

Table 1. Analysis of Enzymes and Soil Samples.

Parameter	Sample used	Method of Analysis	Reference	Appendix Number
		ENZYME ASSAYS		
Amylase	Soil	Colorimetry	Pancholy and Rice, 1973	XII
Urease	Soil	Spectro photometry	Sumner, 1955	XIII
Cellulase	Soil	Colorimetry	Pancholy and Rice, 1973	XIV
		SOIL ANALYSIS		
Nitrogen	Soil, Vermicompost	Titrimetry	Humphries, 1956	XVI
Phosphorus	Soil, Vermicompost	Spectro Photometry	Jackson, 1973	XVI
Potassium	Soil, Vermicompost	Flame photometer	Scholenberger & Simon, 1945	XVII
Organic carbon	Vermicompost	Titrimetry	Jackson, 1973	XVIII
Calcium and Magnesium	Vermicompost	Titrimetry	Cheng & Bray, 1951	XIX

Table 2. Activities of Amylase, Urease and Cellulase in Soil.

Treatments	Amylase (µg of glucose)	Urease (µg)	Cellulase (µg of glucose)
T_0	252.24	6.45	201.29
T_1	377.41	11.91	245.56
T_2	314.87	10.76	270.69
T_3	440.96	9.38	308.59
T_4	340.53	6.47	390.11
T_5	504.61	18.33	541.79
T_6	567.73	15.81	415.76
SED	0.52	0.20	0.27
CD (P< 0.05)	1.12	0.44	0.58

T_0 – Red soil alone
T_1 – Inorganic fertilizer (Triple – 17 complex)
T_2 – *Azospirillum* and *Phosphobacteria*
T_3 – Triple 17 complex + *Azospirillum* and *Phosphobacteria*
T_4 – Vermicompost
T_5 – Vermicompost + *Azospirillum* and *Phosphobacteria*
T_6 – Vermicompost +Triple 17 complex

Sowing Seeds and Maintenances of the Crops

Chilli seeds were sown on each pot directly without any treatment. After germination 100% moisture content was maintained. The plants were protected from the attack of insects and pests.

Soil and Vermicompost Analysis

Enzyme activities of the soil (amylase, urease and cellulase) were also analyzed in the post harvesting stage and predicted in Table 2 and the methods of estimation were given in Table 1.

The initial stage of soil were analyzed for nitrogen, phosphorus, potassium, pH, electrical conductivity and texture, the same was predicted in Table 3. The initial stage of vermicompost were analyzed for nitrogen, phosphorus, potassium, organic carbon, calcium, magnesium and the same was predicted in Table 4. The post harvesting stage of soil were analyzed for nitrogen, phosphorus and potassium and predicted in Table 5 and the methods of estimation were given in Table 1.

Statistical Analysis

The results of the experiments were analyzed by subjecting to statistical analysis like arithmetic mean and analysis of variance.

RESULTS AND DISCUSSION

The results of the study are discussed under the following headings

1. Soil Analysis.
2. Enzyme activities in soil such as amylase, cellulase and urease were determined.
3. Nitrogen, phosphorus and potassium in the redsoil and vermicompost at the initial stage and post harvesting

Table 3. Level of Macronutrients like Nitrogen, Phosphorus, Potassium, pH, Electrical Conductivity and Texture of the soil at the Initial stage.

Constituents	Levels
Texture	Red Soil
pH	8.7
Electrical conductivity	0.176
Nitrogen	69.19 Kg ha^{-1}
Phosphorus	37.06 Kg ha^{-1}
Potassium	395.38 Kg ha^{-1}

Table 4. Biochemical Constituents of Vermicompost.

Nutrients	Vermicompost (%)
Nitrogen	1.68
Phosphorus	0.50
Potassium	0.72
Organic Carbon	10.41
Calcium	160.00
Magnesium	96.00

stage.

Enzyme Activities in Soil

Amylase, Urease and Cellulase activities in soil during the post harvesting stage of chilli were represented in Table 2.

The combined application of Vermicompost +Triple –17 complex (T_6) had increased the amylase activity, whereas the activity of urease and cellulase were found to be higher in the treatment T_5 (Vermicompost + *Azospirillum* and *Phosphobacteria*), when compared to other treatments and control. The activity of amylase in T_6 was recorded as 567.73 µg. Urease and cellulase activities in T_5 were found to be 18.33 µg and 541.79 µg respectively. Control had shown the minimum enzyme activities.

Enzymes in soil are biologically significant as they participate in the cycling of minerals elements and influence their availability to plants. Enzyme activities are very much influenced by the addition of organic manures. The soil management practices that influence the microbial populations are expected to cause changes in the soil enzyme activity. The enzyme activity is considered as an index of microbial activity (Prasad et al., 2005).

Rajashri and Shivapriya (2004) observed that the hydrolytic enzymes present in the soil was activated by *Phosphobacteria* and VAM injection. The amount of phosphatase, cellulase and amylase were higher than the absolute control.

Srinivas *et al.* (2004) stated that the urease activity in the soils collected from rhizosphere of rice increased significantly during the active growth period. Increased enzyme activity was due to the additions of organic amendments and excretion of extra cellular urease by rice plants.

From this study, the enzyme activities and minerals in the soil was found to be better in T_6 (Triple - 17 complex + vermicompost), which was followed by T_5 (vermicompost + *Azospirillum* and *Phosphobacteria*). In general, application of biofertilizers (*Azospirillum* and *Phosphobacteria*) in organic fertilizers (Triple -17 complex) and vermicompost had resulted a positive effect.

Characteristics of Soils at the Initial Stage

The soil used for the study was analyzed for the macronutrients like nitrogen, phosphorus, potassium, pH, electrical conductivity and texture. The same was predicted in Table 3.

Vermicompost Analysis

Vermicompost used for the study was analyzed for organic-carbon, nitrogen, phosphorus, potassium, calcium and magnesium. The data is represented in Table 4.

Soil Analysis at the Post Harvesting Stage

The Table 5 presented the nitrogen, phosphorus and potassium contents of the soil at the post harvesting stage.

Table 5. Level of the Nitrogen, Phosphorus and Potassium contents of the soil at the Post Harvesting stage.

Treatments	Nitrogen Kg ha^{-1}	Phosphorus Kg ha^{-1}	Potassium Kg ha^{-1}
T_0	88.65	14.80	333.41
T_1	130.93	25.27	716.59
T_2	94.21	37.48	348.32
T_3	96.43	16.29	481.35
T_4	172.59	32.37	432.56
T_5	142.72	33.33	420.43
T_6	261.90	37.47	494.28
SED	0.39	0.42	0.36
CD (P<0.05)	0.84	0.91	0.78

Table 5 clearly predicts that there was a significant (P<0.05) improvement in the nitrogen and potassium status of the soil at the post harvesting stage when compared to the initial stage of the soil, whereas there was no improvement in the phosphorus content at the post harvesting stage of all the treatments. The treatment T_6 (Triple – 17 complex + Vermicompost) had improved the nitrogen content very much and was found to be superior among all the other treatments. Similar effect was shown by the treatment T_1 (Triple – 17 complex) with regard to potassium. The improvement in the macronutrient content in the soil may be due to the application of Inorganic fertilizers (Triple – 17 complex), Biofertilizers (Azospirillum and phosphobacteria) and vermicompost.

Kachroo *et al.* (2005) revealed that the application of farm yard manure and higher dosage of nitrogen indicated a positive net balance after harvesting of wheat. Biofertilizer inoculation coupled with FYM and higher dosage of nitrogen enhanced the uptake of nutrients in wheat crop.

The solubilization of phosphorus by Phosphate Solubilizing Bacteria (PSB) is attributed to the excretion of organic acids. The increase in phosphorus availability could be due to the fact that the organic anions compete with phosphate ions for the binding sites on the soil particles and complex organic anion chelate Al^{3+}, Fe^{3+} and Ca^{2+} and thus decrease the phosphate precipitation power of these cations (Tomar, 2000).

The increase in macronutrients like N, P and K and the micronutrients like Fe, Mn, Cu, Zn was highest when combined application of 75% RNP, Rhizobium, PSB and FYM in the soil after the harvesting stage. This might be due to the addition of these nutrients through chemical fertilizers, FYM and biofertilizers (Devi *et al.,* 2005).

Conclusion

Organic farming and organic recycling would play the dual purpose of minimizing pollution and utilizing manures from wastes for increasing the soil productivity. Organic farming on a farm improves its organic matter content. Organic matter consists of plant residues, dead animal residues and animal excretions as well as the decomposing bodies of soil. Organic matter improves soil structure, water holding capacity, assures a regular supply of micronutrients and supporting the growth of beneficial microorganisms. Availability of macronutrients from organic manure is not as fast as chemical fertilizers because it depends upon the rate of their decomposition, soil temperature and moisture.

From the present study it was concluded that

1. The vermicompost is rich in macronutrients like nitrogen, phosphorus and potassium and micronutrients like, calcium, magnesium, zinc, iron etc. It is also rich in vitamins, antibiotics and growth hormones.
2. The treatment T_6 showed the increased amylase activity where as T_5 showed the maximum Urease and cellulase activities in the soil.
3. Analysis of soil in the initial and post harvesting stage, there was an increase in the nitrogen and potassium.

From this study it was concluded that the integrated supply of nutrients through biofertilizers, chemical fertilizers and vermicompost is an efficient method of increasing the enzymes and minerals in soil. Therefore in future the locally available sources of organic fertilizers should be used on a continuous basis for replenishing the degraded physico – chemical properties of the soil. It is recommended that development of soil and plant testing approaches for making fertilizer on the basis of system approach.

REFERENCES

Adeboye, M.K.A., Iwvafor, E.N.O., Agbenin, J.O. (2006). The effects of crop rotation and nitrogen fertilization on soil chemical and microbial properties in a Guinea Savanna Alfisol of Nigeria. *Plant Soil*, 281: 97-107.

Bama, K.S., Kumari, G.S., Mani, P.J. (2005). Role of humic acid and fertilizers on soil enzymes. *J. Ecotoxicol*; 17 (2) 109-112.

Cheng, K.L., Bray, R.H. (1951). Determination of calcium and magnesium in soil and plant material. *Soil Sci*., 72: 42-45.

Devi, A.G., Prasad, P.R., Lakshmi, S., Rao, V.S. (2005). Rhizobium and phosphorus solubilizing bacteria on nutrient uptake in groundnut and fertility status of sandy loam soil. *Andhra Agric. J*., 52 (1&2) : 154-158.

Dubey, D.C.(2004). A text book of Biotechnology. S.Chand and company Ltd, NewDelhi, 217-228.

Elvira, C., Goicoechea, M., Sampedro, L., Mato, S., Nogales, R. (1996). Bioconversion of Solid paper-pulp mill sludge by earthworms. Bioresource Technol., 57:173-177.

Gupta, P.K. (2003). Vermicomposting for sustainable agriculture. Agrobios, Jothpur : 19-50.

Humphries, E.C. (1956). Mineral components and ash analysis, In modern methods of plant analysis, Peach, K., Tray., M.V., Vol.I Springer Verlag, Berlin : 468-502.

Jackson, M.L. (1973). Soil chemical analysis, Prentice hall of India, Pvt. Ltd. NewDelhi: 461-464 and 498-516.

Kachroo, D., Bali, A.S., Dixit, A.K. (2005). Effect of biofertilizers, FYM and nitrogen levels on growth, productivity, soil health and nutrient balance under rice-wheat cropping system. *Indian J. Ecol.,* 32 (2): 112-117.

Kaur, N., Benipal, D.S. (2005). Studies on potassium fixation under long-term use of organic manure and inorganic fertilizers. *Indian J. Ecol.,* 32 (1): 32-35.

Lourduraj, A.C. (2006). Identification of optimum quantity of vermicompost for maize under different levels of fertilizers. *J. Ecobiol.,* 18 (1):23-27.

Ndegwa, P.M., Thompson, S.A. (2001). Integrating composting and vermicomposting in the treatment and bioconversion of biosolids. *Bioresour. Technol*., 76:107-112.

Pancholy, S.K and Rice, E.L., 1973. Soil enzymes in relation to old field succession amylase, Cellulase, Invertase, dehydrogenase and Urease. *Soil Sec. Am. Proc*., 37: 47-50.

Prasad, P.R.K., Krishna, Y.R., Anitha, G., Mahesh, M.N.V.A.U., Rao, V.S. (2005). Effect of different organic manures on dehydrogenase activity in salt affected soils of coastal Andra Pradesh. *Andhra Agric. J*., 52 (1&2): 147-149.

Rajashri, I., Sivapriya, O. (2004). Interactive efficacy of phosphobacteria and VAM in Amaranthus species. *J. Ecotoxicol. Environ. Monit.,* 14(3) : 207-213.

Raju, R.A., Rao, A.S., Rupa, T.R. (2005). Strategies for integrated phosphorus management for sustainable crop production. *Indian J. Fertil*., 1(8): 25-28 and 31-36.

Raman, K.V. (2005). Sustaining Soil fertility. The Hindu Survey of Indian Agriculture, 165-167.

Ramos, S.M.C., Silva E.M.E., Dendooven, L. (2005). Vermicomposting of biosolids with cow manure and oat straw. *Biol. Fertil. Soils,* 41: 190-198.

Sathe, T.V. (2004). Vermiculture and organic farming. Daya Publishing House, New Delhi, 36-57.

Schollenbeger, C. J., Simon, R.H. (1945). Determination of exchange capacity and exchangeable bases in soil-Ammonium acetate method. *Soil Sci*., 59: 13-14.

Singh, G., Singh, K.J., Sooch, S.S., Walia, S.S. (2006). Role of biofertilizers in enhancing the efficacy of inorganic fertilizers in relation to growth and yield of wheat (*Triticum aestivum* L.). *Crop Res.,* 31 (1) : 7-21.

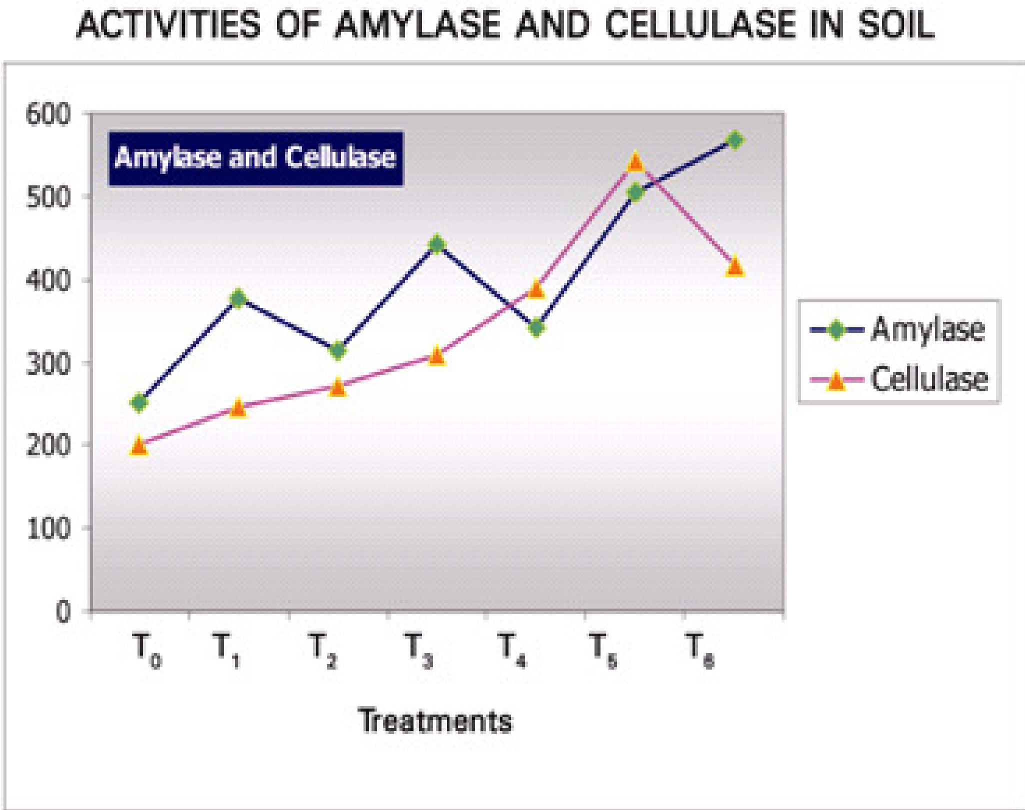
Sparks, D.L. (2001). Dynamics of potassium in soil and their role in management of potassium nutrition. Proc. International symposium on role of K in nutrient management for sustainable crop production in India. New Delhi, Pp.79-101.

Srinivas. D., Raman, S., Rao, P.C. (2004). Effect of organic manures on soil urease activity. *Andra Agric. J.,* 51 (1&2): 77-79.

Sumner, J.B. (1955). Estimation of urease. In: methods in enzymology (Colowick, S.P. and Kaplan, N.O.), 2: 378-379.

Tomar, N.K. 2000 Dynamics of phosphorus in soils. *J. Indian Soc. Soil Sci.,* 48 (4): 640-673.

APPENDIX


ACTIVITIES OF AMYLASE AND CELLULASE IN SOIL
Amylase and Cellulase
600
500
400
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200
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0
T0
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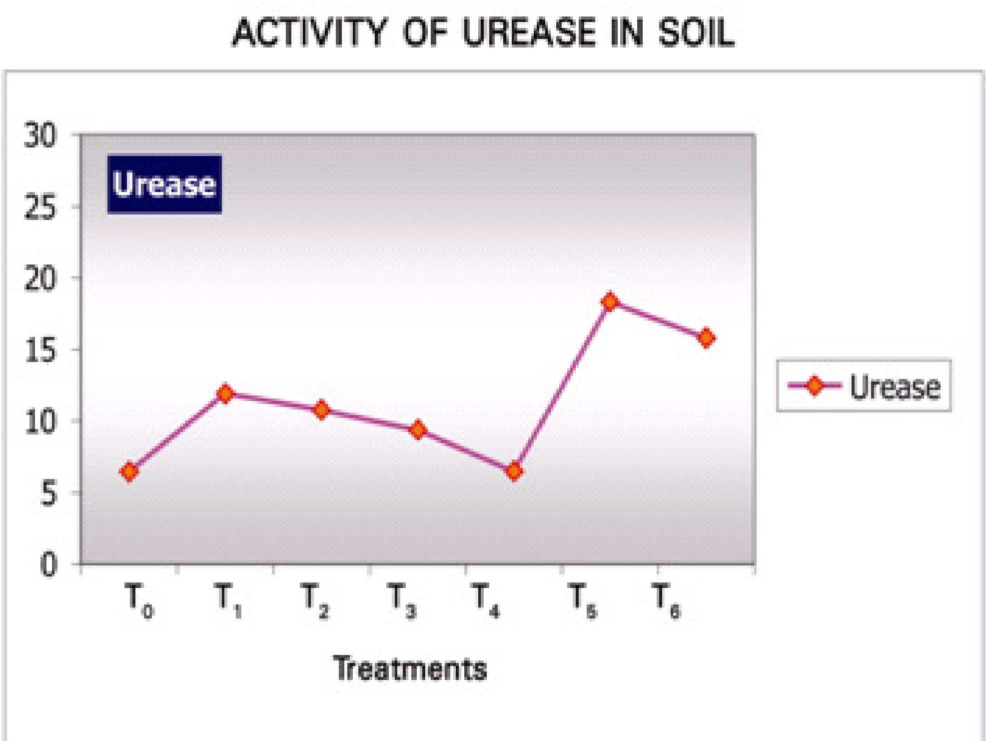
Treatments
Amylase
Cellulase


ACTIVITY OF UREASE IN SOIL
Urease
30
25
20
15
10
5
0
T0
T1
T2
T3
T4
T5
T6
Treatments
Urease

LEVEL OF NITROGEN, PHOSPHORUS AND POTASSIUM CONTENTS OF THE SOIL AT THE POST HARVESTING STAGE