EFFECT OF AGRICULTURAL PRACTICES ON THE STRUCTURE AND FUNCTION OF VESICULAR-ARBUSCULAR MYCORRHIZAE IN MEGHALAYA.

BY

SUSANT KUMAR PARIDA

DEPARTMENT OF BOTANY

SUBMITTED IN FULFILMENT OF THE REQUIREMENT OF THE DEGREE OF DOCTOR OF PHILOSOPHY IN BOTANY OF NORTH- EASTERN HILL UNIVERSITY, SHILLONG.

DEDICATED TO MY PARENTS

THE NORTH-EASTERN HILL UNIVERSITY
MAY , 2002.

I, **Susant Kumar Parida** , hereby declare that the subject matter of this thesis is record of work done by me , and that the contents of this thesis did not form the basis of the award of any previous degree to me or to the best of my knowledge , to anybody else, and that this thesis entitled "***Effect of agricultural practices on the structure and function of vesicular-arbuscular mycorrhizae in Meghalaya***" has not been submitted by me for any research degree in any other University / Institute.

This is being submitted to the North-Eastern Hill University for the degree of Doctor of Philosophy in Botany.

27/8/02 20.8.02 8/7/02

(Head) **(Supervisor)** **(Joint Supervisor)** **(Candidate)**

Susant Kumar Parida

Head
Department of Botany
School of Life Sciences
N. E. H. U.
Shillong-793022

ACKNOW LEDGEMENTS

TO HIM ! WHO IS EVERYTHING

I have no words to express my gratitude and sincere thanks to my Supervisor Dr. (Ms). M.S Dkhar , Reader , Department of Botany , NEHU, Shillong without whose guidance the work would not have been completed.I am equally grateful to Prof. G.D Sharma my joint Supervisor , at present Vice-Chancellor , Nagaland University , Nagaland. I am specially indebted to Prof.R.R.Mishra (Retired) for his insightful suggestions and help.

I express my deep gratitude to Dr. N.D Verma , Director , Dr. Babu Lal , Dr. G.C.Munda, Dr. B.P Patel, Dr. N.P Singh of Indian Council of Agricultural Reaserch , Barapani , Shillong for allowing me to analyse soil and Plant materials in their Laboratory.

I thank Prof. A.K. Mishra, Head Department of Botany, NEHU, Shillong, including all the members of the staff for their constant encouragement and help during the course of my Research work. I thank Prof. A.C.Mohapatra and Dr. N.P Goel, Department of Geography for having allowed me to use computer in the Department.

I am specially grateful to Prof.N.Malla for his constant encouragement, guidance and allround suggestions and help during my research work.

I thank all my Lab mates and particularly my Scholar friend Dr. S.R.Hajong for his generosity at the time of crisis.

Last but not least no word can express my indebtedness towards my parents who sacrificed everything in sending me to Shillong for higher education.

Susant Kumar Parida.

Susant Kumar Parida

CONTENTS

LIST OF FIGURES, TABLES , AND PLATES

List of Figures

List of Tables

Table-75 Showing correlation coefficient (r) values among various infection levels and growth of crop plants (mixed) in net house pot experiment in potato crops of jhum practice soil.

List of Plates

GENERAL INTRODUCTION

The soil of North-East India is generally deficient in nutrient (*Singh et.al.*, 1989) and it takes many years to accumulate and enrich the top soil layers. Soil organic matter also helps in natural regeneration of various crop plants and microbes. In north-east region the most commonly practised agricultural system is Jhum cultivation, which causes depletion of soil organic matter, and indirectly leads to less growth of crop plants. Traditional cutting and burning of forest vegetations have a very crucial effect on vegetation and soil microbial population (Deka and Mishra., 1982). The burning in the forest areas attached to agricultural practices may also affect the population of symbionts (Klopatek *et. al.*, 1988).

Mycorrhiza is almost unique symbiotic association between fungi and the roots of higher plants. The term " Mycorrhiza " was first coined by Frank (1885), a German Pathologist , where he described the essential structure and function of the symbiotic relationship between roots of trees and fungi. Broadly five types of mycorrhiza are recognised on the basis of nature of penetration of fungal hyphae into the host roots. Various soil factors like pH , temperature, moisture, aeration , soil compaction, cutting of trees , addition of chemical fertilisers , jhum cultivation and root exudates may affect the formation of mycorrhizal association. In north-east India in general and Meghalaya in particular, the valley and terrace practices are being observed widely (Plate-1, 2, and 3).

In valley, most of the farmers regularly cultivate various types of crops i.e paddy, maize and potato, whereas, terrace practice mostly observed at high altitudes requiring more

Plate-1: - Showing maize, paddy and potato crops in valley practice.

Plate- 2: - Showing maize, paddy and potato crops in terrace practice.

Plate- 3: - Showing maize, paddy and potato crops in jhum practice.

PO

MZ

PD

VALLEY PRACTICE

PLATE-1

PO

MZ

PD

TERRACE PRACTICE
PLATE –2

PO

MZ

PD

JHUM PRACTICE
PLATE-3

labour input for both ploughing of land and cutting of land into a proper plain form and carrying out oxen and other tools for ploughing of lands.

Any physical and chemical change in the properties of soil reduces the productivity of valley, terrace, and jhum agricultural fields. In Meghalaya, where most of the farmers do not use chemical fertilisers due to their socio-economic conditions and lack of efficient transportation facilities, the vesicular-arbuscular mycorrhizal (VAM) fungi can play an important role in improving the crop productivity.

The importance of VAM fungi in agricultural crops is widely observed (Bethlenfalvay, 1992). Paddy, maize and potato have been found to be infected by VAM fungi under field conditions (Dhillon, 1992). The physiological characters for improved efficiency has received great attention (Tinker, 1975 a, and b). Plants require relatively large amount of phosphate which is immobile and is adsorbed into the soil solution making absorption difficult. The ability of VAM fungi to transfer and translocate different ions varies considerably (Cooper and Tinker, 1978). The distances upto which translocation is effective are quite large in some cases (Rhodes and Gerdemann,1975). Bhattarai (1983) observed high VAM infection in different strains of maize under upland and lowland cultivation practices, however, some more detailed study on the role of VAM in different crops is needed. Phosphorus is considered as the most important nutrient required for growth responses of crop plants to VAM (Krishna and Bagyaraj . , 1982).

There are substantial evidences to show that increased phosphorus uptake is possible because of the capacity of the external hyphae of VAM fungi to absorb phosphate from the soil and translocate it to the host root (Merry weather and Fitter, 1995) Ravanskov and Jakobsen (1995) found that plant fungus combinations were compatible with respect to

mycorrhiza formation, which was measured both as root colonization and growth of external hyphae. They further noted that the symbiosis differed markedly with respect to functional compatibility as phosphorus uptake by each fungus depending on the host plant. According to Nadian *et al.*, (1996) the soil compaction had no significant effect on root length containing arbuscules, and vesicles, but total root length colonized by arbuscules-vesicles or by any combination of arbuscles, vesicles and intra-radical hyphae significantly decreased as soil compaction was increased. Mc Millan *et al.*, (1998) observed inhibition of hyphal growth of a VAM fungus in soil containing sodium chloride and it limits the spread of infection from spores. The mycorrhizal symbiosis enables the plants to have a longer and better distributed root surface area for absorption of nutrients. Besides P the VAM fungi also enhance uptake of N, K and some other microelements (Furlan and Bernier, 1989).

There are some evidences of the functional compatibility of symbioses between host plants and arbuscular-mycorrhizal fungi measured as hyphal P transport to plants (Ravanskov and Jakobsen,1995). It was also observed that nitrogen metabolism of external hyphae of the VAM fungus was quite high in *Glomus intradices* (Jakobsen *et al.* ,1994). Different strains of VAM fungi may vary in their efficiency for nutrient uptake (Jensen,1985) Davis and Fucik, (1986). This difference is generally assigned to the difference in ability of extension of the fungal hyphae from the root surface (Abbott and Robson,1991). Certain evidences show that the hyphae of VAM fungus in wet soil remain infective and it decreases if the soil is disturbed (Robson *et al.*,1989). The number of infectious propagules of indigenous VAM fungi was determined at the rice cropping systems in two varying strata and in a rainfed field on the irrigated farms. The mycorrhizal inoculum was consistently less in poorly field with a rice than in the better drained field with a rice-corn-mungbean pattern (I iag *et al*,1987).

Mycorrhiza also increases the water transport and tolerance of seedlings to drought by providing increased surface area of roots due to massive network of hyphae extended to large distance in soil than root hairs (Abbott and Robson, 1991). The role of mycorrhizal infection in the nutrient uptake particularly phosphorus is well documented. It increases solubilization, absorption and uptake of P from the soils low in phosphorus. It also enhances nitrogen fixation, which results into increased shoot growth, dry matter accumulation, and legumes (Walker *et al.*, 1996). Earthworm also acts as a very good vector of viable propagules of mycorrhizal fungi in various crop fields (Reddell and Spain, 1991).

In the recent past due to changes in environmental conditions caused by over exploitation of forest resources and destruction of vegetation during jhum cultivation and other deforestation activities and also due to use of chemical fertilisers particularly a decrease in the microbial activity in soil is observed. This may also result in change in the soil composition. In such situation it may be difficult to enhance the crop productivity in nutrient deficient fields.

Keeping in mind the above factors including socio-economic conditions of the farmers, the beneficial role of extramycorrhizal mycelium to plants is worth investigating.

Therefore in the present investigation it was planned to study the following aspects:-

(a) Regular (Monthly) survey of vesicular-arbuscular mycorrhizal association with certain crop plants (potato, maize, and paddy) under different agricultural practices (valley,terrace,and jhum) for infection level , hyphal biomass and total root infection.

(b) The isolation of VAM fungal species and their diversity in different soils under various agricultural practices and interaction between VAM and earthworms in dispersal of spores .

(c) Physico-chemical properties (pH, moisture content, organic matter, N, P, and K) of soils of different fields .

(d) Quantification of extramycorrhizal mycelium and its role in the transfer of nutrients from soil to plants.

(e) The interspecies interaction of crops from VAM compatibility in different agricultural systems in terms of their mycorrhizal hyphal mass in soil and its efficiency to improve the growth of plants.

STUDY SITES AND CLIMATE

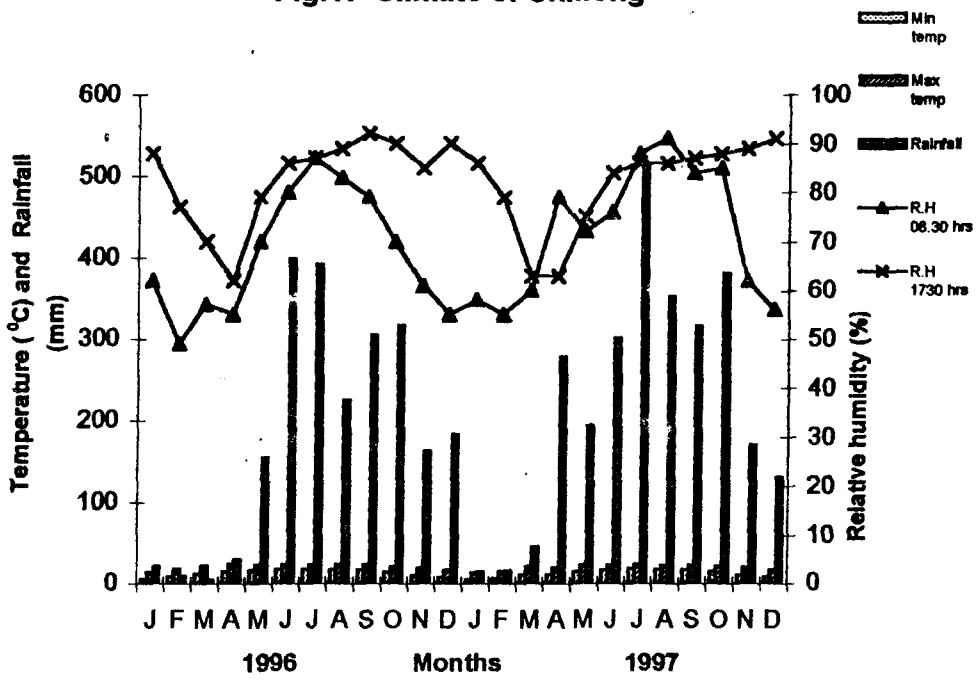
Shillong, the capital of Meghalaya is located at 25° 34'N and 91° 56' E. The altitude of Shillong is 1500m above sea level. Three different crops (paddy, maize and potato) growing in three fields differing in agricultural practices were selected for the present study. They were (i) valley land at Kyntonmassar (altitude 1000 m.s.l.), (ii) terrace land near Sanker rehabilitation centre (altitude 1100 m.s.l.) and (iii) jhum land at Umphyrnai (altitude 1600 or 1625 m.s.l.). The data of temperature, rainfall and relative humidity during the study periods (1996 and 1997) has been presented in Fig-1. The soil of Meghalaya is generally acidic and red laterite in nature. The pH of soils of three experimental sites ranged between 4.2 to 5.6.

Sub-tropical climatic condition is generally found in Shillong, where the maximum temperature goes upto 28°C in May-Jun and the minimum temperature drops down to (1-3)°C in the month of Jan. The annual rainfall of all the three study areas i.e valley, terrace and jhum was 2292.2mm in 1996 and 2715.3mm in 1997. The highest rainfall was found from Apr to Oct, from Nov to Feb the rainfall was very less. In these study sites heavy rainfall and high altitude mountains result into high relative humidity through out the year except from Mar-Jun. The annual relative humidity of the three experimental sites was 67% in morning 0830 hrs and 53% in evening 1730 hrs in 1996 and 62% in morning 0830 hrs and 56% in evening 1730 hrs in 1997. According to Meteorological survey the year may be broadly classified into rainy (May-Aug), Autumn (Sep-Oct) , winter (Nov-Feb) , and spring (Mar-Apr) seasons. the rainy season starts from May and ends in Aug . The maximum rainfall (approximately 75%) occurs during Jun-Jul .Autumn season starts from Sep-Oct, whereas winter season commences from the beginning of Nov till middle of Feb , this period shows low temperature

and less rainfall as well , The spring season starts from middle of Feb and extends up to Mar , and the period is characterised by high velocity of wind , less humidity and moderate temperature.

The field experiments were conducted at Kyntonmassar agricultural field near University campus i.e valley and terrace land towards Sanker road (altitude 1100m.s.l.) and jhum land is situated 18 km away from the University campus towards Smit and area is called Umphymai (altitude 1600m.s.l.).

Fig.1:- Climate of Shillong



REVIEW OF LITERATURE

The term "Mycorrhiza" was propounded by Frank (1885) a German Pathologist. It is the symbiotic association between the roots and fungi, which has been divided into two types called as ectomycorrhiza and endomycorrhiza.The later has again been divided into three groups i.e vesicular-arbuscular, ericaceous and orchidaceous.

Galloud (1905) found the presence of vesicular-arbuscular mycorrhiza (VAM) in the roots of many angiospermic plants and described two types of VAM infection differing in the length and location of arbuscules.

Peyronel (1923) examined the hyphal connections between the fruiting bodies and mycorrhiza in the soil and included these endophytes under the genus Endogone.

Asai (1943) grew the plants in sterilised soil as well as in a mixture of sterilised and unsterilised soil and observed the occurrence of mycorrhizal infection in the mixed soil condition. The mycorrhizal plants also showed better growth than non-mycorrhizal ones.

Mosse (1953) observed the fruiting bodies of endogone attached to extramatrical mycelium of mycorrhizal roots of strawberry.

Mosse and Bowen (1968) found out the characters for identification of different types of Endogonaceous spores based on the nature of cytoplasm, wall structure of spores, presence or absence of attached hyphae the attachment of hyphae and the colour of spores.

Peyronel *et.al.*, (1969) gave three terminology for the common types of mycorrhizas viz. ectomycorrhizae, endomycorrhizae and ectendomycorrhizae.

Hayman, (1970) observed that the endogone spore numbers changed little from Dec to Jun greatly increased in Jul and began to decrease in Sep, due to application of formalin.

Mosse and Hayman (1971) observed the improved growth of the plants pre-inoculated with VAM fungi, transplanted to the pots containing unsterilised soil.

Baylis (1970 and 1971) examined that the genera deficient in root hairs have greater dependence on mycorrhizas or added phosphorus for growth in phosphorus deficient soils than the plants with finely branched root systems and numerous root hairs.

Daft and Nicolson (1972) observed a quantitative relationship among the size of root systems, infection of pigmentation of roots and the ectocarpic chlamydospores production in tomato and maize inoculated with endogonemacrocarpa.

Sutton and Barron (1972) found a new technique "floation-adhesion technique" for the recovery of spores from the soil. They also observed the seasonal change in the spore numbers in the soil. The number of spores showed a decreasing trend depth wise.

Crush (1973) found a very interesting dual behaviour of mycorrhizal fungus *Glomus tenuis*. It depressed the growth rate of grass in the limited conditions of glass house but stimulated the same under field conditions.

Hattingh *et.al.* , (1973) found that mycelial network of endomycorrhizal fungi enables plants to explore a larger volume of soil beyond the root surface.

Bakshi (1974) studied the ectomycorrhizal associations of Indian trees, and other crops. He also isolated and identified the endogonaceous spores in the Indian soil and showed their effects on the growth of various plants under different fertilizer treatments.

Ho and Trappe (1975) observed that the VAM fungi *Glomus mosseae* and *G.macrocarpus* had the nitrate reductase system by which they were capable of reducing the nitrate.

Hattingh and Gerdemann (1975) suggested a more practical method of establishing the quick and desired mycorrhizal establishment in the seedlings by sowing the seed pelleted with efficient mycorrhizal inoculum.

Sahni (1976) observed better growth of mycorrhizal paddy plants over non-mycorrhizal ones.

Powell (1976b) observed that the introduced VAM strains were more efficient in stimulating the growth of white clover as compared to the indigenous ones and concluded that the white clover was highly dependant on infection by mycorrhizal fungi in many hill country soils of New Zealand.

Sanders *et al.*, (1977) reported that of four VA endophyte inoculated on onion plants three enhanced the growth, whereas one showed no growth.

Powell and Daniel (1978) observed that the mycorrhizal plants could recover the soluble as well as insoluble forms of phosphate more than the non-mycorrhizal plants.

Sparling and Tinker (1978a,b & c) observed small seasonal effect in root infection and recorded highest infection in winter. In case of grasses the mycorrhizal uptake of P was found

to be significant only when the soil was severely depleted, otherwise the fine much branched root system was sufficient for the same.

Giovannetti and Mosse (1979) calculated the standard error of four methods of assessment on stained root samples and found that all the measurements were substantially over estimated if the percentage of infection recorded as the propertion of cortex occupied by fungus and even more if it is regarded as the propertion of total root mass.

Heap and Newman (1979) found by buried slide techinique that hyphal connections exists between different roots on one plant *Lolium perenne L.*, and also between two roots of different species *L.perenn* and *Plantago lanceolata L.*

Mishra (1979) examined the distribution of endogone species and the mycorrhizal status of the forest trees in the humid forest of Meghalaya. The mycorrhizal associations of the important species of ferns of north-east India was reported by Mishra *et al.*, (1980). all the fern species studied possessed the vesicular-arbuscular type of *Glomus* ,*Gigaspora Acaulospora and Sclerocystis* which were isolated from the soils where different fern species were growing.

Kellam and Schenck (1980) studied interaction between VAM fungus *Glomus macrocarpus* and a root knot nematode *Meloidogyne incognita* in soybean and with both the organisms had significantly fewer galls per gram root, greater root weights and higher yields than those infected with nematode only. They also observed that the presence of mycorrhizal fungi reduced the number of galls formed by the nematode and the presence of the nematode affected the mycorrhizal development only in the immediate area of the gall. However , the

nematodes , had little effect on the mean percentage infection and the chlamydospore production by the VAM fungus.

Rose (1980) reported VAM associations in some actinomycetous nodulated nitrogen fixing plant species. Rose and Youngberg(1989) also studied the effect of mycorrhiza on these plant species and found the increase in growth as well as the P and N contents of the plants having this tripartite associations.

Schenck and Kinloch (1980) found the early colonization of roots and extramatrical production of spores in 6 crops grown as monoculture for 7 years in a newly cleared site and got variable response of different types of mycorrhiza on different crops.They concluded that such variable responses were little affected by other factors except the specific host characteristic which seemed to be more important.

Mishra *et al* ., (1980) reported that mycorrhizal plants grow robust and produced three times more dry weight than non- mycorrhizal plants.

Clarke and Mosse (1981) found better yield production when barley crop was inoculated with VA endophyte in field though they obtained even higher yield by only adding phosphate.

Cooper and Tinker (1981) reported that the translocation of phosphates in the hyphae occurred normally by protoplasmic streaming but they did not rule out the possibility of a bulk flow of hyphal content under a water potential gradient.

Jakobsen and Anderson (1981) observed that mycorrhiza developed more slowly after inoculation in irradiated soils than in untreated soils and also found that available soil P increased with increasing irradiation dose.

Ocampo and Hayman (1981) found that the amoúnt of VAM infection in a host plant was not depressed in soil previously cropped with a "non-host" plant even when the roots of preceding "non-host" plant were retained intact in the soil. contrary to the expectation , the presence of "non-hosts" stimulated the early development of VAM in the host crops . They also found the vesicular-arbuscular hyphae growing in the moribund roots of "non-hosts".

Bierman and Linderman (1981) found a different method of evaluating the mycorrhizal status of plant in which they estimated the percentage of length of the root segments containingVAM fungal structure instead of determining the percentage of infection of roots.They got the 10 % of the mean when 7 samples each with 25 randomly selected 0.5 to 1.0 cm root segments were examined.

Clarke and Mosse (1981) observed better yield when barley crop was inoculated with VA endophyte in field. They also found that without any addition of phosphate in soil, only mycorrhizal infection doubled the production of ears in terms of fresh weight but when phosphate was added it increased the ear production more than inoculation.

Manjunath and Bagyaraj (1981) observed the effect of different components of VAM inoculum on the growth of onion. The infected root segments and the extramatrical chlamydospores both stimulated the growth but the former was more efficient than the latter one. However , the use of only associated microorganisms of the roots or the sterilised infected segments as inoculum failed to enhance the growth at all.

Allen (1982) increased water transport and reduced resistance to water flow with mycorrhizal infection . He suggested that one of the major factor may be the increased absorptive root surface area provided by the VAM fungal hyphae.

Azcon *et al.*,(1982) proved that soil nitrate influence mycorrhizal development by acting on the establishment of infection rather than on spread within the root.

Jensen (1982) reported that *Glomus constrictus* and the two isolates of *G.fasciculatus* enhanced the growth rate of barley along with the increased uptake of P, Cu, and Zn whereas *Gigaspora margarita* proved poor to do so and the effect was not more than the non-mycorrhizal control.

Bierman and Linderman (1983) found that intra-radical vesicle increases the inoculum potential of mycorrhiza.

Bolan and Robson (1983) observed that increasing P supply frequently decreases the percentage of root length infected by VAM fungi.

Hepper (1983) suggested that application of nitrate resulted in higher level of VAM infection by *Glomus mosseae* at 3 P levels. At high P concentrations infection was inhibited but at low P concentration, level was related to N content of host. Treatments with low N resulted in few arbuscules and intercellular hyphae.

Pfeiffer and Bloss, (1987) observed that growth of guayale (*Parthenium argentatum A. Gray*) in a moderate and a highly saline-sodic soil was increased by inoculation with *Glomus intradices* Schenck and Smith (1989) , and found that growth of guayale plants was stimulated equally by the addition to the soil of either 100 g of phosphorus or inoculum of *G. intraradices*.

Zajicek *et al*. ,(1987) reported that seedlings of *Batisia australis* and *Liatris aspera* grown in prairie soil with no additional phosphorus benefitted significantly from inoculation by *Glomus etunicatum*, regardless whether seedlings were adequetly watered or moderately or severely drought stressed *Glomus etunicatum* was found by them as more efficient than *Glomus mosseae* in increasing dry weight of both plant species and infection level under both well watered and droughted conditions.

Evans and Miller (1988) examined that soil disturbance in zero-tilled soil significantly reduced P and Zn absorption by maize grown in soil originating from three sites differing in local geography.

Fairchild and Miller (1989) observed that the higher level of mycorrhizal colonization have clearly been effective in improving the nutrition of plants in the undisturbed soil.

Miranda *et al.* (1989) found that translocation of phosphorus into roots growing in unsuplemented soil had little effect on percentage root infection, spore number or external hyphae in that compartment although infected root length increased slightly and also found in treatment where soil P and plant P were high percentage root infection and external hyphal growth were both similarly reduced.

Abbott, *et al*. , (1989) examined the hypothesis that hyphae of a VAM fungus in dry soil remain infective , but that the infectivity decreases if the soil is disturbed.

Brundrett and Kendrick, (1989) developed a new experimental procedure to produce sample of leek roots containing early stages in colonization by VAM fungi.

Evans and Miller (1988) examined the VAM colonization of young maize plants (*Zea mays*) is inhibited by soil disturbance and found that the undisturbed mycelial network

may also increase the nutrient absorption capacity independent of the degree of colonization.

Jasper *et al.* , (1991) found that the mycorrhizal colonization of clover roots in the infectivity test was not decreased after soil was disturbed and both in forest and heathland soil the percentage root length colonized of test plants was almost had been disturbed.

Marinissen and Ruiter (1993) found that Earthworms contribute to nitrogen mineralization directly , through consumption , digestion, respiration, excretion and indirectly by influencing population dynamics of predation or through affecting environmental conditions.

Vogelzag *et al* . , (1993) found that mycorrhizal infection of roots is influenced by environmental factors including soil temperature.

Ravanskov and Jakobsen (1995) found that all plant fungus combinations were compatible with respect to mycorrhiza formation measured both as root colonization and growth of external hyphae and found that the symbioses differed markedly with respect to functional compatibility as phosphorus uptake by each fungus depended on the host plant.

Gardes and Dahlberg (1995) observed that the mycorrhizal diversity in artic and alpine tundra is based mainly on mycorrhizal associations of plant taxa in specific habitats, and it appears that typical arbuscular mycorrhizal associations are ubiquitous in low artic and alpine areas , but the level of root colonization is highly variable.

Bago, *et al* (1996) observed that the effect of the extraradical mycelium of the VAM fungus *Glomus intraradices* on nitrate uptake and on the pH medium with tomato roots

from organ culture, found that the symbiosis was established in compartmented petridishes containing agar media amended with the pH indicator bromocresol purple.

Ibijibijen and Uraquiga, (1996) found that the ^{15}N enrichment of the non-nodulating beans decreased significantly when infected by mycorrhizal fungi.

Ravanskov and Jakobsen (1995) found the functional compatibility in VAM directly related with the hyphal P transport to the plants.

Clapp *et al* (1995) found the diversity of fungal symbionts in VAM from a natural community.

Mc Gee *et al.* , (1997) found that soil borne spores and hyphae of VAM fungi are important propagules in cracking soils of northern N .S.W, Australia.

Nadian *et al* . ,(1996) observed that soil compaction had no significant effect on the fraction of root length containing arbuscules and vesicles, but total root length colonized by arbuscules , vesicles or by any combination of arbuscules, vesicles, and intra-radical hyphae significantly decreased as soil compaction was increased.

Scott *et al.* , (1996) reported that fungicides reduced the infection and transfer of "P" from soil to the plants.

Walker et al (1996) reported a new fungal species forming arbuscular mycorrhizas.

Johansen *et al* (1996) concluded that external hyphae of the VAM fungus *G. intradices* help in nitrogen metabolism.

Omar, (1996) observed that growth effects of VAM fungus *G. constrictum* on maize plants in pot trials is very effective.

Ibijbijen *et al* (1996) reported that the role of VAM fungi on growth , mineral nutrition and nitrogen fixation in three varieties of common beans(*Phaseolus vulgaris*) is very much effective.

Bagyaraj and Varma (1996) studied the interaction between arbuscular mycorrhizal fungi and plants, which helps in sustainable agriculture in arid and semi-arid tropics.

McGee *et al* (1997) found that the survival of propagules of VAM fungi in soils in eastern Australia is used to grow.

Braunberger (1996) found that the infectivity of VAM fungi remains active after wetting and drying.

Becker (1996) examined that successive pot cultures shows high species richness of VAM fungi in arid-ecosystem.

Gasper *et al* (1997) found the variations in the lipid composition of actaalfa roots during colonization with the VAM fungus *G. versiforme*.

Nadian *et al* (1997) observed the effect of soil compaction on plant growth, phosphorus uptake and morphological characterstics of VAM colonization with *Trifolium subterraneum* ,where soil compaction reduces VAM colonization.

Nagahashi and Douds (1997) reported that the appresorium formation by VAM fungi on isolated cell walls of carrot roots.

De clerck *et al* (1998) observed from a monoxenic culture of intraradical forms of *Glomus sp* isolated from a tropical ecosystem and also invented a methodology for germplasm collection.

Mc Rillag *et al* (1999) concluded that the percent root infection by VAM fungi and infection intensity of *Bromus hordeaceus* grown in an elevated atmospheric CO_2.

Mc Millan *et al* (1998) found the inhibition of hyphal growth of a VAM fungus in soil limits the spreads of infection from VAM fungal spores.

Fontenia *et. al* . (1999) Studied the influence of VAM on non-host plants *Stellaria media* (*Caryophyllaceae*) , *Chenopodium album* and *Spinaceae oleracea* (*Chenopodiace)* , *Brassica compestris* , *B* . *nigra* , *Capsella bursa pastoris* , and *Sisymbrium altissimum* (*Brassicaceae*) , *Juncus balticus* (*Juncace*) , *Urtica dioca* (*Urticaceae*) and of the AM host plant *Taraxacum officinale* (*Asteraceae*) on the colonization of *pisum sativum* by VAM fungus *G.mosseae* and the result showed that the roots of non-host species have factors that seem to affect the AM fungus before it establishes in the root of host plants.

Vierheilig *et. al.* , (2000) Observed split root system with barley plants , one half of the divided root system had been colonized by AM fungi *G. mosseae* , *G. intradices* , or *Gigaspora rosea*. Prior colonization of one half of the split root system with any of the three fungi resulted in a clear suppression of colonization by *G.mosseae* in the other half of the root system.

John and Rangarajan , (2001) tested six VAM fungi for their ability to increase the biomass by colonization of roots and phosphatase activity in three varities of *pappaya* (*Carica*

pappaya L.) . Among six VAM fungi *G.mosseae* was most effective in increasing the shoot and root dry weight over control treatments.

Khaliq *et. al* . , (2001) Studied the influence ot three species of VAM fungi namely *G.aggregatum* , *G. fasciculatum* and *G. mossede* and concluded that the growth of *peppermont* (*Metha piperita L.*) under glass house condition showed that *G.fasciculatum* enhanced the highest shoot biomass 145.3% followed by *G.aggregatum* (131.1 %) and *G.mosseae* (87.8 %) in comparision to control.

Wagner *et. al* ., (2001) Studied pure cultures of AM fungus containing approximately 80 spores / g were stored in Dotham soil under four different temperature-moisture regiments and observed that the best method of AM fungi culture storage in Dotham soil is at 4^0c and moisture conditions, field capacity.

CHAPTER- I

Status of Vesicular- arbuscular mycorrhiza with certain crop plants under different agricultural practices.

Introduction

It has been observed that large number of vesicular-arbuscular mycorrhizal spores are present in the crop fields. It may not be possible for spores and mycorrhizal root fragments to compensate for the decrease of infectivity after the damage to the hyphal network by soil disturbance (Jasper *et al.*,1987). Little information is available on the survival of hyphae of VAM fungi in dry soil (Jasper *et al.*,1987). The fungal spores show a diverse community in natural climate (Jasper *et al.*, 1989b). Colonization of new roots by VAM fungi occurs rapidly in valley soils (Jasper *et al.*,1989c). This colonization is due to the contact with a previous infective hyphae in the crop fields (Jasper *et al.*,1989b). The infectivity of external hyphae of both *Acaulospora laevis* and *Glomus species* decreased in the disturbed valley soil (Jasper *et al.*,1989c). It has been noted that presence of grasses and weeds may result in large number of mycorrhizal roots in the increase of spores and mycorrhizal propagules in the field. The growth and development of VAM fungi are affected by many ecological factors like pH, relative humidity, moisture content, soil bulk density and porosity (Bruce *et al.*,1994). A marked variation, however, is noted during the jhum (shifting cultivation) practice (Lozano *et al.*, 1990). The spore population generally increases in crop fields with suitable temperature, pH, relative humidity and nutrient level of soil (Clapp*et al.*,1995). Low soil aeration also reduces growth and development of VAM fungi.

It has been observed that any change in mycorrhizal colonization in more compacted soil might have been due to either the physical effect of compaction or to differences in the

concentration of P (Nadian *et al.*,1996). The spore population may vary in each seasons due to climatic variations. Only highly resistant species like *Glomus* and *Gigaspora* may survive, whereas less resistant species like *Sclerocystis*, *Modicella*, and inter and intraspecific variations may be visible within the morphologically similar arbuscular fungi i.e *G. mosseae* and *G. coronatum* (Walker *et al.*,1996).

The culture of earthworm species improves the number of VAM spores in agricultural fields (Malcon *et al.*,1989). Earthworms also act as a good vector for dispersal of arbuscular mycorrhizal fungal spores from one place to another (Walker and Rosendahl,1993).

Materials and Methods

Collection of the rhizosphere soil samples:- The rhizosphere soil and the roots of the three different crops (i.e., paddy, potato and maize) were collected from three different agricultural practices i.e valley (V), terrace (T), and jhum (J) separately in sterilised polythene bags, tied with rubber bands then brought to the laborotory. With samples collected the following studies were made.

Isolation of endogonaceous spores:-

The isolation of spores was done by wet sieving and decanting methods of Gerdeman and Nicolson (1963). Five g of rhizosphere soil was stirred in a beaker containing 500 ml of distilled. water for 30 minutes, allowed to settle down the heavier soil particles, spores being lighter float over water surface . Spores were separated from soil particles by passing through the sieves of different sizes 200, 150, 90, and 50 micron. The spores on the sieves were washed under tap water to remove any soil particles and organic debris. Then the spores were

collected separately, filtered through whatman No-1 filter paper and counted under binocular stereo microscope.

Isolation of spores from earthworm :-

The collected earthworms in the sterilised polythene bags from three different agricultural fields were kept in chloroform for 5-10 minutes and dissected. Soils from earthworm intestine were collected and the spores were isolated by wet sieving and decanting methods of Gerdeman and Nicolson (1963).

Determination of mycorrhizal infection :-

Fine root segments of 1cm length of three selected crops were cut. From these 100 segments were randomly taken, placed in 100 % KOH solution and autoclaved for 30 minutes. Then the sterilised root segments were properly washed with water, slightly acidified by transferring them in 5 % acetic acid for 10 minutes and then stained with 0.05 % trypan blue in lactophenol following the technique of root clearing and staining (Phillips and Haymans , 1970) for rapid assessment of VAM . The root segments were washed in lactophenol to remove surplus stain, mounted on microscopic slides in lactophenol and examined under microscope for VAM spores and structures like external hyphae, internal hyphae, entry points, vesicles and, arbuscules. The % root infection was calculated as follows:

$$\% \text{ root infection} = \frac{\text{Number of infected cells}}{\text{Total number of cells}} \times 100$$

(Phillip and Hayman, 1970)

Estimation of hyphal biomass :- (Ride, and Drysdale, 1972)

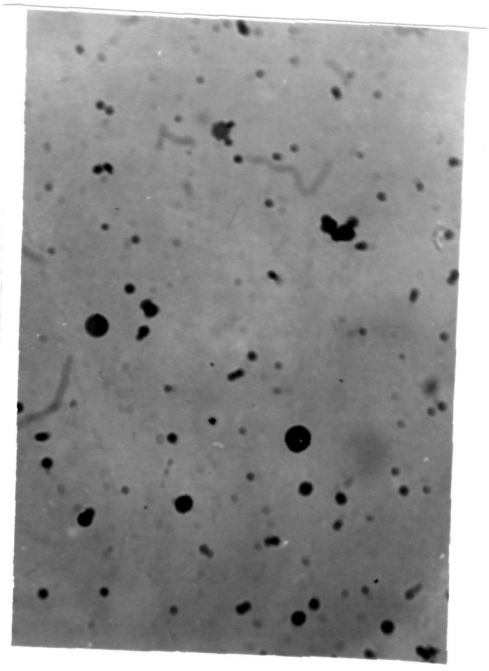
One g of oven dry powdered soil collected from three different agricultural practices was separately mixed with acetone, subsequently washed with distilled water and treated in conc.KOH solution (120 g in 100ml of dist. H_2o) at 130^0 C for 90 minutes, the remaining alkali was removed through centrifugation . The residue in the form of chitosan was deaminated with 1.5 ml of $NaNo_2$, 1.5 ml of KH_2SO_4 and 1.5 ml of sufamate ($NH_4SO_3NH_2$) was finally reacted with 1.5 ml of 3-methyl-2-benzothiozoline hydrazone hydrochloride (MBTH) and 1.5 ml of $FeCl_2$ at 650nm and subsequently reacted with MBTH and $FeCl_3$ for comparison.

Plate-4: - Showing total number of VAM spore population.

Plate-5: - Infection levels in maize, paddy and potato crops of valley practice.

Plate-6: - Infection levels in maize, paddy and potato crops of terrace practice.

Plate-7: - Infection levels in maize, paddy and potato crops of jhum practice.



VAM SPORE POPULATION

PLATE-4

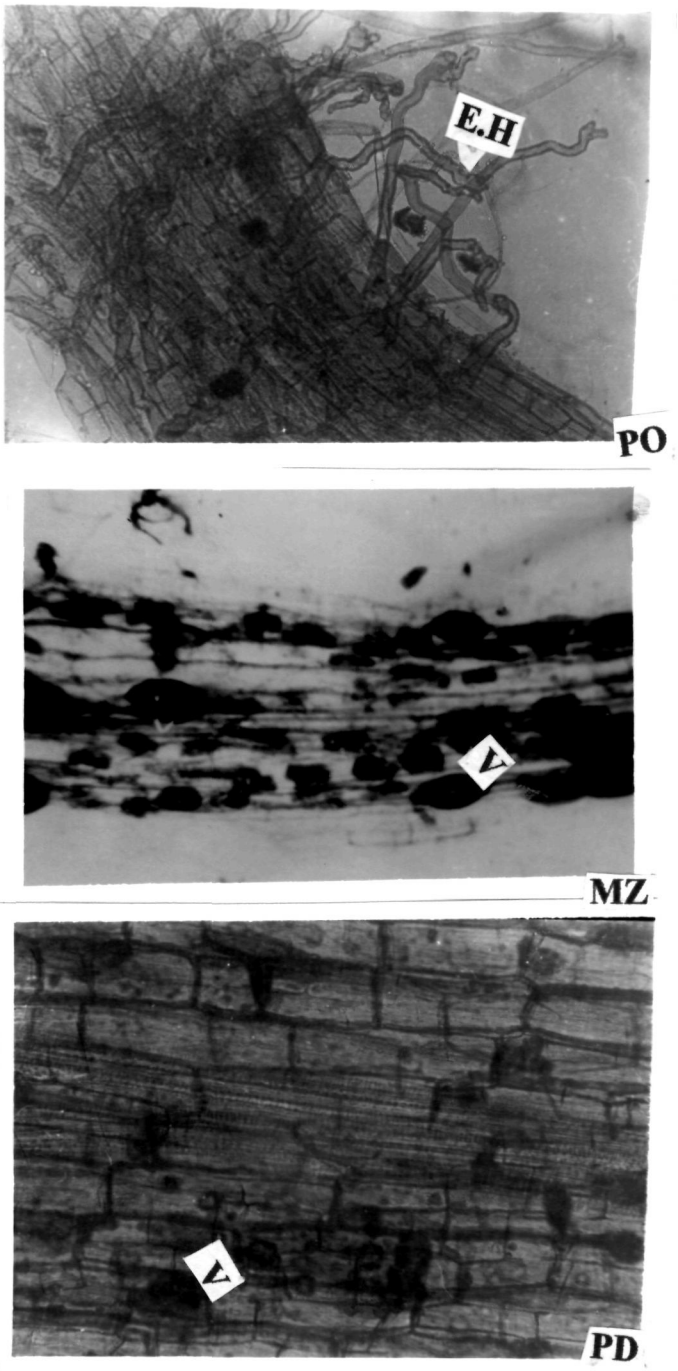
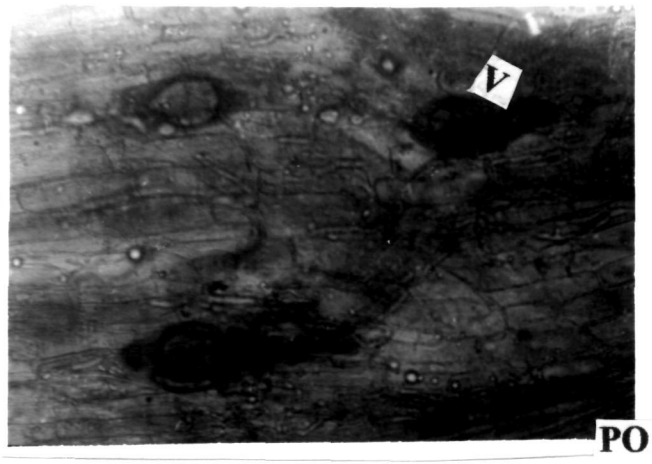
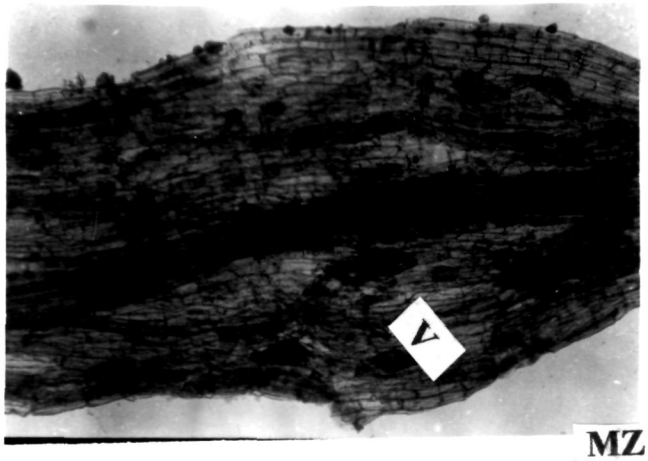


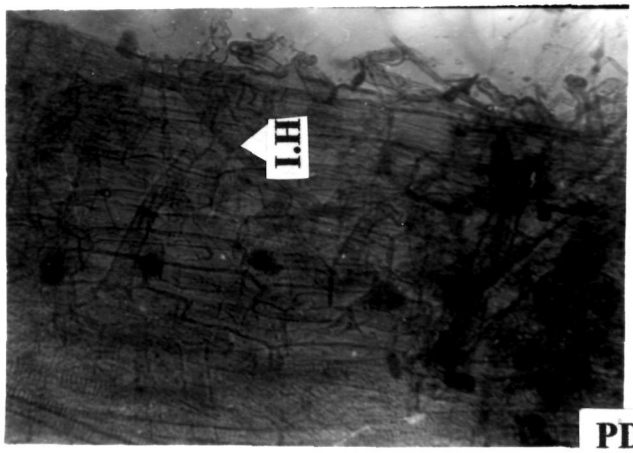
PLATE –5



PO



MZ



PD

PLATE-6

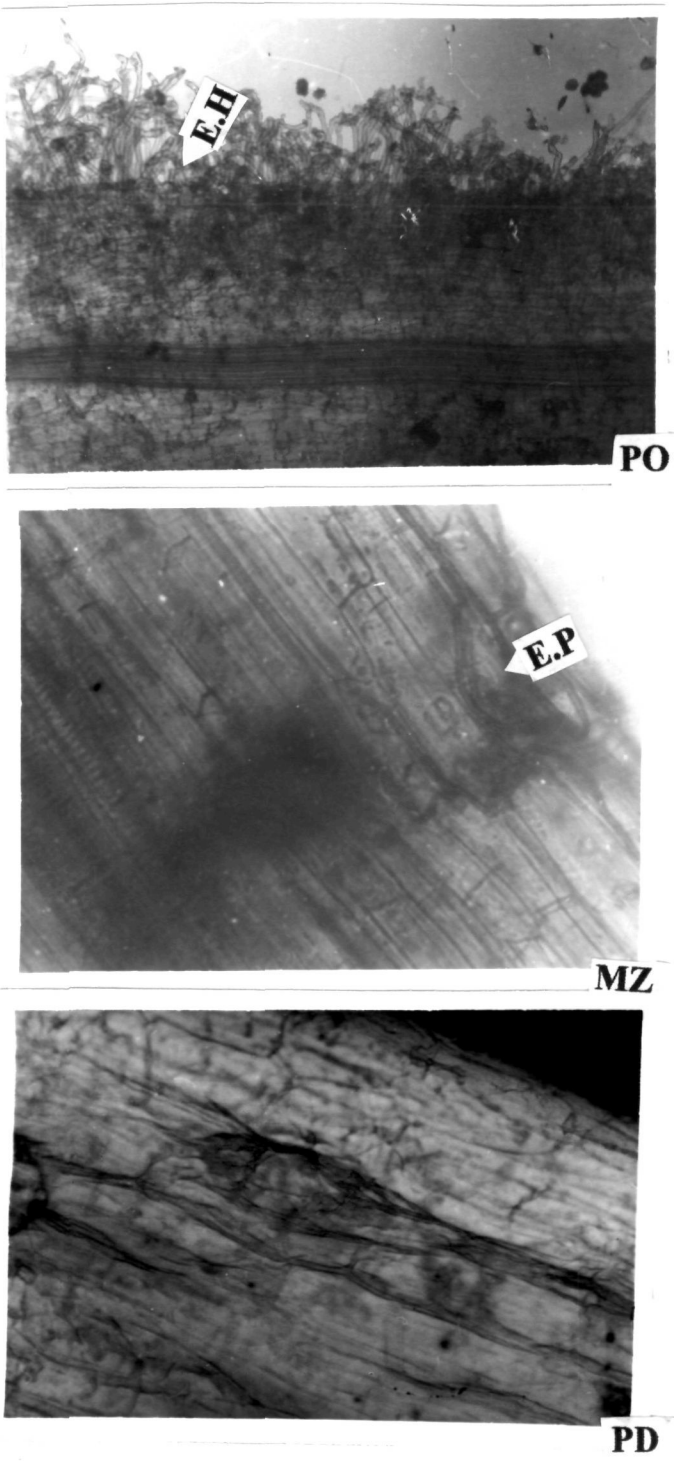


PLATE-7

Fig 2:-Hyphal biomass of Valley, Terrace and Jhum practices soil.

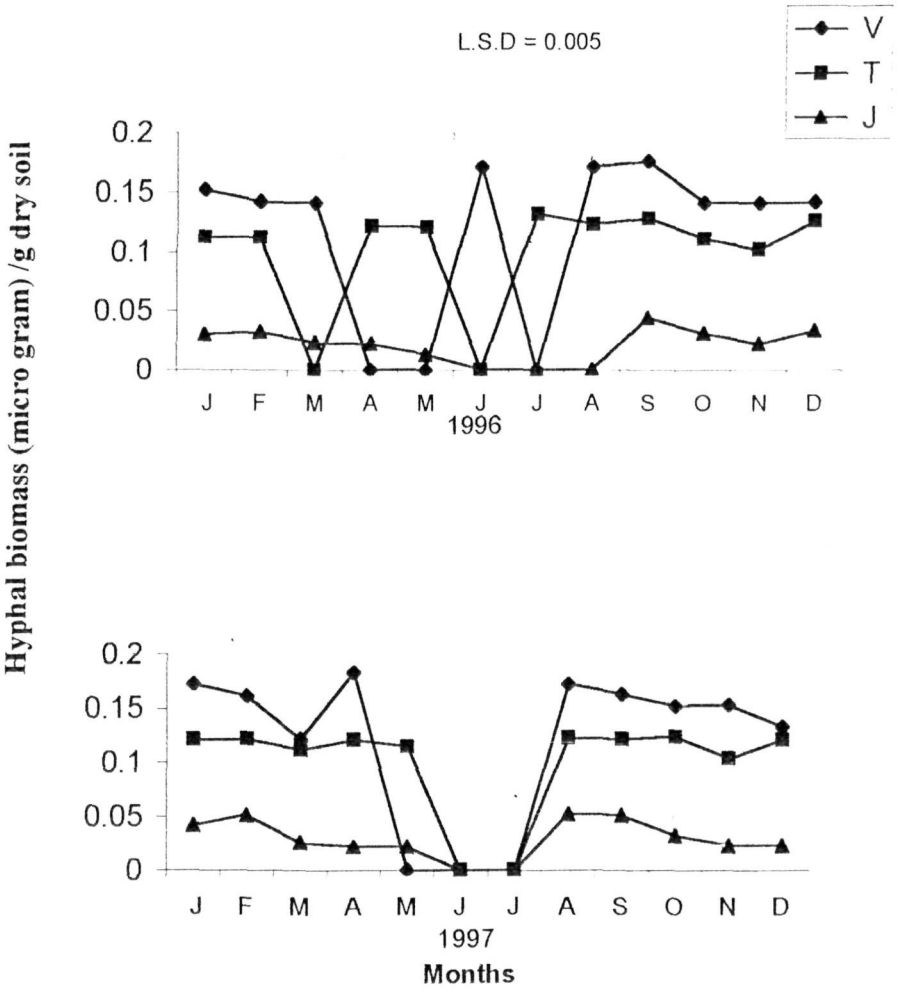


Fig-3:- Total VAM spore population of Valley, Terrace and Jhum practices in rhizospheric soil , cast and earthworm gut contents

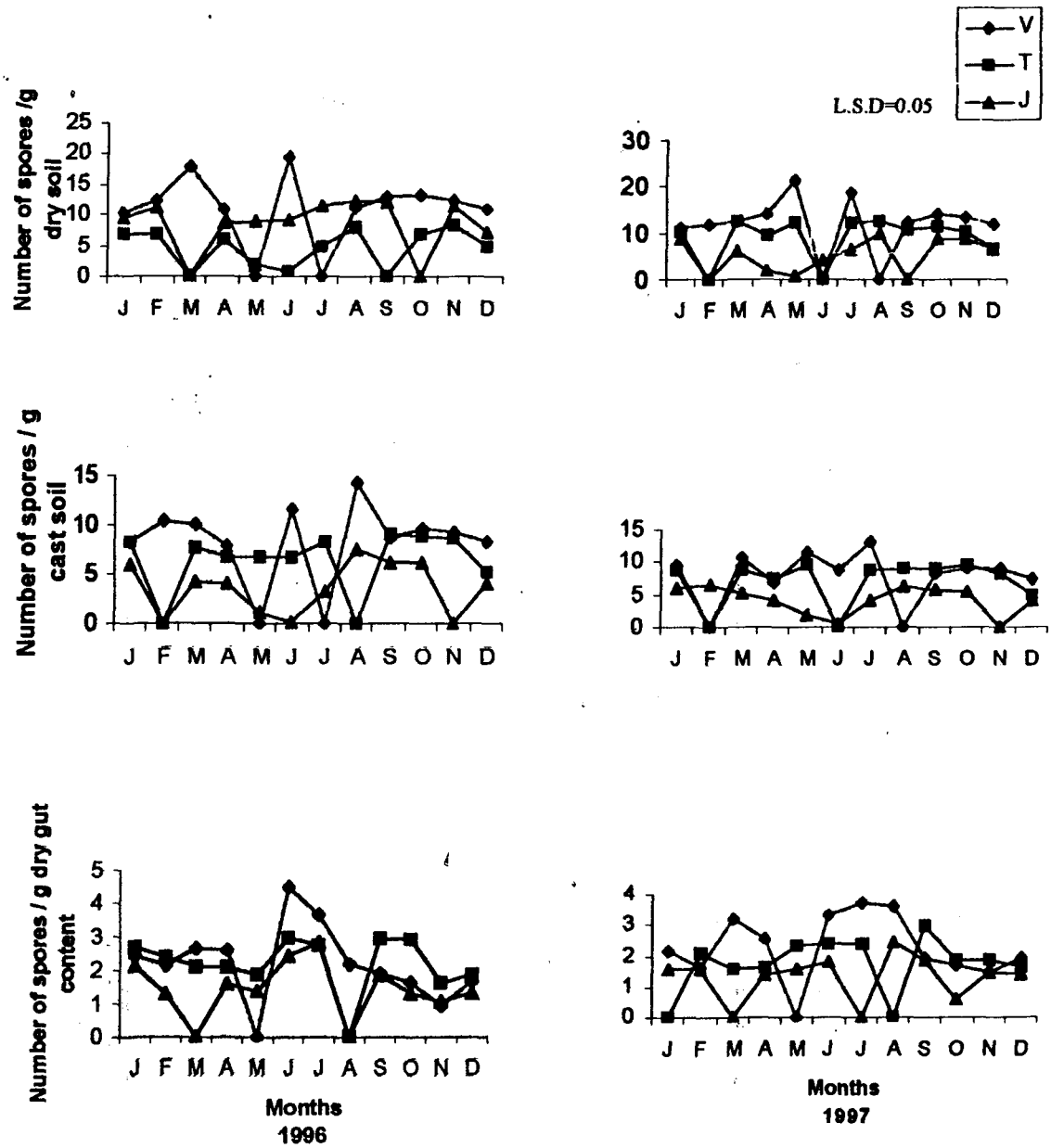


Table-1:-Infection level (total number of external hyphae,internal hyphae,entry points,vesicles,arbuscules and %infection) in maize, paddy and potato crops in Valley Practice in the year 1996

Sampling Period (Months)	Crop Name	No. of E.P./cm Seg	No. of E.H./ cm Seg	No. of IH/cm Seg	No. of V/cm Seg	No. of A/cm Seg	Total Cells/cm Seg	% Inf/cm Seg
Jan	PO							
	MZ							
	PD							
Feb	PO	11.11	14.63±0.05	12.18	9.16	10.16	152.12±0.05	58.18
	MZ							
	PD							
Mar	PO	14.23	21.23±0.05	19.23±0.05	9.12	7.16	120.12	53.18
	MZ							
	PD							
Apr	PO	16.16	18.18	17.56	7.12	11.11	152.13	68.16±0.025
	MZ							
	PD							
May	PO	18.23±0.015	18.82	20.62±0.025	10.15	12.12	151.14	62.16
	MZ	8.11	8.62	10.08	7.68	6.12	120.16	32.12
	PD	13.12	22.28	24.81±.05	11.23	13.11	157.68	56.18±0.05
Jun	PO	19.11±.05	16.68	18.82	7.53	9.11	121.23	59.15±0.015
	MZ	10.16	12.23	13.12	9.23	8.12	153.23	36.16
	PD	11.23	24.15±0.05	21.13	10.16	12.16	161.41±0.05	58.12
Jul	PO							
	MZ	12.13	19.16±0.025	17.16	11.68	12.11	162.61	42.62
	PD	14.21	17.18	19.11	10.28	11.13	132.23	48.62
Aug	PO							
	MZ	13.51	22.12	13.51	8.38	11.21	120.52	52.62
	PD	16.23	16.16	18.23	10.23	12.52	129.61	36.61
Sep	PO							
	MZ	16.16	16.82	18.82±.05	7.76	9.23	161.11±.05	53.23
	PD	12.34	22.82±.05	21.35	9.23	11.22	136.16	56.26±.05
Oct	PO							
	MZ	13.23	18.38	16.61	10.82	12.18	152.23	46.16
	PD	12.16	16.56	16.12	7.76	9.16	182.28	32.23
Nov	PO							
	MZ	8.51	11.68	12.23	6.66	8.23	152.18	50.16±.05
	PD	11.22	12.18	14.28	6.68	10.6	161.16	42.16
Dec	PO							
	MZ	11.16	15.18	16.18	6.23	7.12	129.12	38.23
	PD							

E.P :- Entry point, E.H:- External hyphae,I.H:-Internal hyphae,V:-Vesicles,A-Arbuscules,PO:-Potato,MZ:-Maize,PD:-Paddy

± = S.E

Table-2:-Infection level (total number of external hyphae, internal hyphae,entry points,vesicles,arbuscules and %infection) in maize, paddy and potato crops in Valley Practice in the year 1997

Sampling Period (Months)	Crop Name	No. of E.P./cm Seg	No. of E.H./cm Seg	No. of IH/cm Seg	No. of V/cm Seg	No. of A/cm Seg	Total Cells/cm Seg	% Inf/cm Seg
Jan	PO							
	MZ							
	PD							
Feb	PO	10.23	22.23	22.61	9.11	9.26	156.26	62.16±0.05
	MZ							
	PD							
Mar	PO	12.21	20.16	16.22	9.12	7.22	156.23	50.23
	MZ							
	PD							
Apr	PO	14.16±0.015	17.22	18.23	8.23	13.11	152.2	42.26
	MZ							
	PD							
May	PO	16.11	19.23	20.2±0.505	10.28	12.12	161.16	58.28
	MZ	6.12	9.16	7.71	6.61	5.16	138.2	32.16
	PD	14.16	20.22	23.2	9.23	11.12	123.11	52.23
Jun	PO	18.13±0.205	18.16±0.505	20.01	8.28	11.29	158.16±0.105	57.66
	MZ	9.23	13.18	12.23	8.21	8.66	129.19	38.18
	PD	13.28	23.29	22.21	8.51	11.62	128	48.23
Jul	PO							
	MZ	11.56	18.33	18.51	11.11	10.68	152.2	45.26
	PD	16.11	18.34	20.61±0.05	8.61	10.23	151.16±0.05	53.35
Aug	PO							
	MZ	12.12	18.44	15.71	11.22	10.16	123.23	46.66
	PD	16.23	12.25	18.23	10.23	12.16	136.11	62.62±0.005
Sep	PO							
	MZ	15.28	18.22	18.81	8.61	8.18	120.28	52.63
	PO	11.22		21.23	9.28	10.12	128.61	58.83
Oct	PO							
	MZ	12.23	20.23	17.61	8.29	11.23	152.23	56.28
	PD	13.26	19.18	17.82	8.33	10.12	121.61	42.55
Nov	PO					8.16	152.21	36.23
	MZ	10.16	16.61	12.23	8.2			
	PD	9.61	14.51	16.81	7.32	7.16	162.23	56.66
Dec	PO						1	
	MZ	10.23	15.23	17.23	8.2	7.21	128.25	38.23
	PD							

E.P :- Entry point, E.H:- External hyphae,I.H:-Internal hyphae,V:-Vesicles,A-Arbuscules,PO:-Potato,MZ:-Maize,PD:-Paddy

± = S.E

Table-3:- Infection level (total number of external hyphae, internal hyphae, entry points, vesicles, arbuscules and %infection) in maize, paddy and potato crops in Terrace Practice in the year 1996

Sampling Period (Months)	Crop Name	No. of E.P./cmSeg	No. of E.H./cm Seg	No. of IH/cm Seg	No. of V/cm Seg	No. of A/cm Seg	Total Cells/cm Seg	% Inf/cm Seg
Jan	PO							
	MZ							
	PD							
Feb	PO	12.16	18.61±.05	13.61	7.12	5.11	128.21	38.16
	MZ							
	PD							
Mar	PO	14.15	19.68±.05	18.28	8.16	7.11	152.52	46.11
	MZ							
	PD							
Apr	PO	16.23	16.23	15.31	6.12	9.16	152.23	48.16
	MZ							
	PD							
May	PO	14.18	14.41	16.51	8.11	11.12	118.27	33.16
	MZ	9.18	11.23	8.2	3.03	4.15	121.51	26.2
	PD	12.52	19.86±0.045	20.22±0.405	8.03	7.18	168.2±0.105	42.1
Jun	PO	18.23±0.035	14.28	16.11±0.05	8.23	8.16	128.11	28.16
	MZ	12.28	15.11	12.18	5.61	6.66	126.13	32.23
	PD	11.68	22.23	18.09	7.23	11.77	182.15	46.66
Jul	PO							
	MZ	15.66	18.48	15.66	7.21	8.68	134.16	46.62±0.045
	PD	16.62	18.45	14.08	6.66	8.23	132.12	52.11
Aug	PO							
	MZ	14.23	21.23	11.55	8.15	11.28	142.82	38.18
	PD	12.21	16.28	17.22	7.12	9.92	153.13	42.52
Sep	PO							
	MZ	13.16	15.66	16.52	8.18	10.11	162.62	46.38
	PD	12.18	20.28	19.92	7.62	10.52	143.62	53.16
Oct	PO							
	MZ	11.12	15.32	14.66	9.62	8.23	122.11	37.23
	PD	11.23	13.31	14.23	8.28	7.28	128.61	32.15
Nov	PO							
	MZ	16.33	9.46	11.16	6.22	7.66	108.28	33.66
	PD	11.28	12.21	11.28	6.68	6.23	124.43	42.21
Dec	PO							
	MZ	9.11	11.28	11.16	7.82	6.86	128.21	32.01
	PD							

E.P :- Entry point, E.H:- External hyphae,I.H:-Internal hyphae,V:-Vesicles,
A- Arbuscules,PO:-Potato,MZ:-Maize,PD:-Paddy
± = S.E

Table-4:-Infection level (total number of external hyphae,internal hyphae,entry points,vesicles,arbuscules and %infection) in maize, paddy and potato crops in Terrace Practice in the year 1997

Sampling Period (Months)	Crop Name	No. of E.P./cm Seg	No. of E.H./cm Seg	No. of IH/cm Seg	No. of V/cm Seg	No. of A/cm Seg	Total Cells/cmSeg	% Inf/cmSeg
Jan	PO							
	MZ							
	PD							
Feb	PO	11.16	18.11	18.11	7.12	4.22	116.2	28.16
	MZ							
	PD							
Mar	PO	13.12	20.16	20.12	7.18	6.51	125.19	30.21
	MZ							
	PD							
Apr	PO	15.23	15.23	17.12	8.61	8.68	120.16	48.23
	MZ							
	PD							
May	PO	13.56	15.18	16.16	8.12	6.23	152	42.21
	MZ	8.22	10.23	8.61	4.23	3.52	116.18	26.51
	PD	13.23	17.52	21.61	7.28	6.11	118.19	48.21
Jun	PO	16.28	14.22	16.12	8.51	7.61	126.28	38.22
	MZ	11.11	14.21	12.31	6.23	5.2	126.36	30.2
	PD	12.16	20.28±0.055	20.51±0.05	8.81	10.11	152.32	42.51
Jul	PO							
	MZ	14.28	17.23	18.23	7.61	8.12	138.23	43.61
	PD	14.18	18.63	17.21	6.76	10.23	128.28	48.23
Aug	PO							
	MZ	13.16	20.62±0.015	20.51±0.035	7.28	10.11	121.28	46.21
	PD	12.12	15.62	19.61	8.51	10.62	119.72	46.51
Sep	PO							
	MZ	13.23	15.28	16.23	6.62	10.18	128.28	42.31
	PD	11.66	21.86	18.28	8.23	10.11	152	52.52
Oct	PO							
	MZ	11.28	15.92	15.11	7.51	11.91	152.46	48.22
	PD	12.11	13.66	13.1	9.62	7.81	126.28	38.81
Nov	PO							
	MZ	13.28	9.23	12.16	8.52	7.82	123.12	35.82
	PD	11.66	12.66	11.12	6.23	8.82	152.23	36.23
Dec	PO							
	MZ	10.7	12.15	10.18	6.23	8.23	128.23	31.56
	PD							

E.P :- Entry point, E.H:- External hyphae,I.H:-Internal hyphae,V:-Vesicles,A-Arbuscules,PO:-Potato,MZ:-Maize,PD:-Paddy

± = S.E

Table-5:-Infection level (total number of external hyphae,internal hyphae,entry points,vesicles,arbuscules and %infection) in maize, paddy and potato crops in Jhum Practice in the year 1996

Sampling Period (Months)	Crop Name	No. of E.P./cm Seg	No. of E.H./cm Seg	No. of IH/cm Seg	No. of V/cm Seg	No. of A/cm Seg	Total Cells/cm Seg	% Inf/cm Seg
Jan	PO							
	MZ							
	PD							
Feb	PO	11.16	13.23	14.12	7.16	9.18	152.2	36.23
	MZ							
	PD							
Mar	PO	12.12	16.22	14.32	6.12	8.16	132.2	32.22
	MZ							
	PD							
Apr	PO	16.18	12.26	13.51	6.12	10.19	162	28.51
	MZ							
	PD							
May	PO	16.19	13.2	16.61	7.13	8.22	152.62	18.66
	MZ	9.21	8.66	6.23	3.23	3.23	139.2	13.22
	PD	13.23	12.22	13.62	6.22	10.26	128.28	18.23
Jun	PO	17.51	10.5	12.18	7.66	9.19	132.16	16.11
	MZ	10.16	12.2	8.23	5.68	5.22	128.11	16.12
	PD	14.62±.205	13.56	14.28	6.62	8.32	152.66	16.19
Jul	PO	14.62	12.11	12.18	8.62	10.32	128.23	14.16
	MZ	13.23	14.61	11.66	7.63	8.62	156.28	18.68
	PD	12.82	15.23	13.22	6.3	8.82	128.32	26.23
Aug	PO							
	MZ	18.51±.105	16.56	13.11	8.28	10.23	122.66	29.22
	PD	16.23	14.28	13.12	8.29	10.32	128.28	28.12
Sep	PO							
	MZ	13.61	12.66	14.16	8.3	10.35	146.23	32.15±0.065
	PD	14.62	13.62	14.82	8.32	10.4	152.52	32.18
Oct	PO							
	MZ	13.86	16.23	15.13	6.32	7.01	123.21	29.92
	PD	12.26	15.51	15.12	6.28	7.16	143.51	38.68
Nov	PO							
	MZ	10.52	10.23	9.21	5.66	6.66	138.21	36.18±0.045
	PD	9.66	9.51	10.23	6.68	7.22	141.23	33.23
Dec	PO							
	MZ	9.86	11.61	11.22	5.23	6.34	128.51	26.11
	PD							

E.P: - Entry point, E.H:- External hyphae,I.H:-Internal hyphae,V:-Vesicles,A-Arbuscules,PO:-Potato,MZ:-Maize,PD:-Paddy

± = S.E

Table-6:-Infection level (total number of external hyphae,internal hyphae,entry points,vesicles,arbuscules and %infection) in maize, paddy and potato crops in Jhum Practice in the year 1997

Sampling Period (Months)	Crop Name	No. of E.P./cm Seg	No. of E.H./cm Seg	No. of IH/cm Seg	No. of V/cm Seg	No. of A/cm Seg	Total Cells/cm Seg	% Inf/cm Seg
Jan	PO							
	MZ							
	PD							
Feb	PO	9.16	10.23	13.11	8.32	10.13	132.23	25.16
	MZ							
	PD							
Mar	PO	11.12	15.21	12.16	7.52	8.36	136.16	29.18
	MZ							
	PD							
Apr	PO	14.16	12.54	12.28	6.61	8.23	130.18	23.92
	MZ							
	PD							
May	PO	13.12	12.11	16.28	8.44	8.58	123.22	20.22
	MZ	8.66	10.1	9.29	3.45	4.44	132.22	18.28
	PD	12.86	14.16	12.23	8.54	7.68	139.32	19.32
Jun	PO	16.68	12.21	13.2	6.2	8.23	123.22	19.56
	MZ	10.38	11.55	11.16	5.21	6.66	128.18	21.26
	PD	15.32	12.21	12.18	6.21	9.18	136.16	15.26
Jul	PO	13.21	13.55	11.92	7.28	9.08	148.12±0.065	23.86
	MZ	12.32	14.86	12.21	7.86	8.12	152.28	26.66±0.055
	PD	11.81	15.55	12.68	6.62	10.11	166.86± 0.05	23.65
Aug	PO							
	MZ	16.62	19.19	12.66	7.73	8.16	182.62± 0.05	25.82
	PD	13.53	16.22	11.28	6.62	10.62	152.12	32.23±0.045
Sep	PO							
	MZ	11.55	18.32	10.92	8.86	11.08	129.82	28.82
	PD	14.52	20.11	11.66	7.92	10.63	149.43	36.86±0.045
Oct	PO							
	MZ	11.66	13.16	13.23	8.66	10.63	128.28	32.86
	PD	12.76	12.68	15.56	6.62	8.23	152.28±0.025	32.16
Nov	PO							
	MZ	9.77	13.69	11.28	5.22	8.56	120.38	38.15±0.015
	PD	8.81	12.83	12.66	5.33	7.18	152.25±0.035	27.25
Dec	PO							
	MZ	10.76	12.26	11.82	4.22	7.11	132.72	23.23
	PD							

E.P :- Entry point, E.H:- External hyphae,I.H:-Internal hyphae,V:-Vesicles, A-Arbuscules,PO:-Potato,MZ:-Maize,PD:-Paddy
± = S.E

Table-7:- Correlation coefficients (r) values among various infection levels i.e External hyphae(E.H) . Internal hyphae (I.H). Entry point (E.P). Vesicles (V) Arbuscules A. and % infection in valley practice in 1996 and 1997 in maize, paddy and potato crops.

	1996		MZ				1997		MZ			
	E.P/Seg	E.H/Seg	I.H/Seg	V/Seg	A/Seg	%Inf/Seg	E.P/Seg	E.H/Seg	I.H/Seg	V/Seg	A/Seg	%Inf/Seg
E.P/Seg	1						1					
E.H/Seg	0.740585	1					0.686746	1				
I.H/Seg	0.85669	0.606633	1				0.837696	0.919484	1			
V/Seg	0.037239	0.402186	0.417098	1			0.521699	0.850556	0.739399	1		
A/Seg	0.595675	0.90654	0.659204	0.730187	1		0.476961	0.858	0.75611	0.940782	1	
%Inf/Seg	0.95308	0.841703	0.695154	-0.0336	0.628956	1	0.985762	0.773779	0.905981	0.566691	0.530357	1
			PD									
infection levels	E.P/Seg	E.H/Seg	I.H/Seg	V/Seg	A/Seg	%Inf/Seg			PD			
E.P/Seg	1						E.P/Seg	E.H/Seg	I.H/Seg	V/Seg	A/Seg	%Inf/Seg
E.H/Seg	0.862189	1					1					
I.H/Seg	0.618918	0.384563	1				0.817424	1				
V/Seg	0.497745	0.620071	0.763227	1			0.907724	0.969605	1			
A/Seg	0.75193	0.868847	0.619044	0.816559	1		0.851252	0.853304	0.863675	1		
%Inf/Seg	0.817485	0.60433	0.911196	0.695033	0.765607	1	0.630937	0.709117	0.744518	0.820194	1	
			PO						PO			
	E./Seg	E.H/Seg	I.H/Seg	V/Seg	A/Seg	%Inf/Seg	E.P/Seg	E.H/Seg	I.H/Seg	V/Seg	A/Seg	%Inf/Seg
infection levels	1						1					
E.H/Seg	0.843066	1					0.824018	1				
I.H/Seg	0.747382	0.820177	1				0.699191	0.457064	1			
V/Seg	0.824061	0.747977	0.817308	1			0.590846	0.749705	0.762814	1		
A/Seg	0.836395	0.859597	0.982716	0.900869	1		0.385132	0.632862	0.638667	0.94951	1	
%Inf/Seg	0.757591	0.677664	0.932265	0.764365	0.916921	1	0.415739	0.513424	0.788219	0.93724	0.941992	1

Table-8 :- Correlation coefficients (r) values among various infection levels i.e External hyphae (E.H) , Internal hyphae (I.H) , Vesicles (V) , Arbuscules (A) and % infection in terrace practice in 1996 and 1997 in maize , paddy and potato crops.

MZ 1996

Infe tion levvels	E.P/Seg	E.H/Seg	I.H/Seg	V/Seg	A/Seg	%Inf/Seg
E.P/Seg	1					
E.H/Seg	-0,724	1				
I.H/Seg	-0,224	0,768	1			
V/Seg	0,336	0,318	0,742	1		
A/Seg	0,317	0,369	0,747	0,935	1	
%Inf/Seg	-0,461	0,909	0,859	0,604	0,553	1
			PD			
	E.P/Seg	E.H/Seg	I.H/Seg	V/Seg	A/Seg	%Inf/Seg
E.P/Seg	1					
E.H/Seg	0,024	1				
I.H/Seg	-0,487	0,624	1			
V/Seg	-0,687	-0,348	0,245	1		
A/Seg	-0,293	0,635	0,340	-0,452	1	
%Inf/Seg	0,431	0,682	0,299	-0,687	0,506	1
			PO			
	E.P/Seg	E.H/Seg	I.H/Seg	V/Seg	A/Seg	%Inf/Seg
E.P/Seg	1					
E.H/Seg	-0,28997	1				
I.H/Seg	-0,32925	0,139554	1			
V/Seg	0,823933	-0,08684	-0,032	1		
A/Seg	0,589834	-0,63094	-0,47192	0,629	1	
%Inf/Seg	-0,22115	0,694541	0,487934	0,264	-0,263	1

MZ1997

Infe tion levvels	E.P/Seg	E.H/Seg	I.H/Seg	V/Seg	A/Seg	%Inf/Seg
E.P/Seg	1					
E.H/Seg	-0,405	1				
I.H/Seg	-0,321	0,614	1			
V/Seg	0,300	-0,804	-0,114	1		
A/Seg	0,243	-0,114	-0,474	0,129	1	
%Inf/Seg	0,888	-0,206	0,024	0,252	-0,045	1
			PD			
	E.P/Seg	E.H/Seg	I.H/Seg	V/Seg	A/Seg	%Inf/Seg
E.P/Seg	1					
E.H/Seg	0,269	1				
I.H/Seg	-0,132	0,568	1			
V/Seg	-0,664	-0,234	-0,464	1		
A/Seg	0,183	0,382	-0,030	0,0436	1	
%Inf/Seg	0,071	-0,032	0,482	-0,686	0,206	1
			PO			
	E.P/Seg	E.H/Seg	I.H/Seg	V/Seg	A/Seg	%Inf/Seg
E.P/Seg	1					
E.H/Seg	0,082	1				
I.H/Seg	-0,390	-0,532	1			
V/Seg	-0,094	0,432	-0,248	1		
A/Seg	0,206	0,713	-0,568	-0,283	1	
%Inf/Seg	-0,079	0,674	0,088	0,092	0,499	1

Table-9 :- Correlation coefficient (r) values among various infection levels i.e External hyphae (E.H) , Internal hyphae (I.H) , Entry point (E.P) , Vesicles (V) , Arbuscules (A) , and % infection in jhum practice in 1996 and 1997 in maize , paddy and potato crops..

MZ 1996

	E.P/Seg	E.H/Seg	I.H/Seg	V/Seg	A/Seg	%Inf/Seg
E.P/Seg	1					
E.H/Seg	0,282	1				
I.H/Seg	0,814	0,770	1			
V/Seg	-0,231	0,168	0,075	1		
A/Seg	0,256	-0,361	-0,007	0,126	1	
%Inf/Seg	0,306	-0,317	-0,022	-0,388	0,850	1

PD

	E.P/Seg	E.H/Seg	I.H/Seg	V/Seg	A/Seg	%Inf/Seg
E.P/Seg	1					
E.H/Seg	-0,640	1				
I.H/Seg	0,249	0,066	1			
V/Seg	0,080	-0,140	0,600	1		
A/Seg	0,402	-0,739	0,372	0,108	1	
%Inf/Seg	-0,288	0,663	0,132	-0,612	-0,171	1

PO

	E.P/Seg	E.H/Seg	I.H/Seg	V/Seg	A/Seg	%Inf/Seg
E.P/Seg	1					
E.H/Seg	-0,56355	1				
I.H/Seg	-0,17438	0,494139	1			
V/Seg	0,31005	-0,70847	-0,12927	1		
A/Seg	0,274704	-0,59697	-0,58482	-0,126	1	
%Inf/Seg	-0,89597	0,466481	0,010315	-0,555	0,130182	1

MZ 1997

	E.P/Seg	E.H/Seg	I.H/Seg	V/Seg	A/Seg	%Inf/Seg
E.P/Seg	1					
E.H/Seg	-0,742	1				
I.H/Seg	-0,079	0,450	1			
V/Seg	-0,099	0,428	0,1892	1		
A/Seg	0,595	-0,709	0,230	-0,130	1	
%Inf/Seg	-0,018	0,663	0,763	0,467	-0,249	1

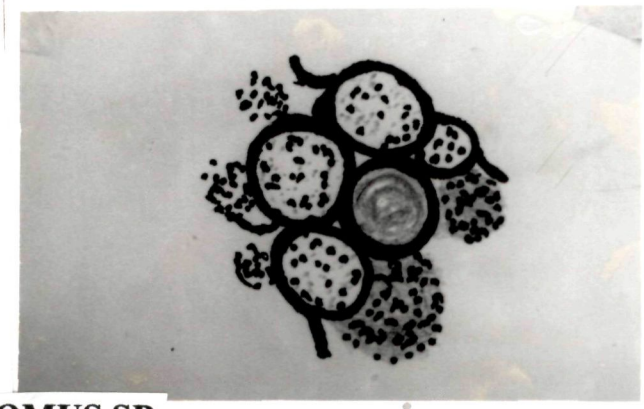
PD

	E.P/Seg	E.H/Seg	I.H/Seg	V/Seg	A/Seg	%Inf/Seg
E.P/Seg	1					
E.H/Seg	-0,716	1				
I.H/Seg	-0,530	0,964	1			
V/Seg	0,886	-0,943	-0,854	1		
A/Seg	0,900	-0,528	-0,302	0,718	1	
%Inf/Seg	0,691	-0,763	-0,654	0,799	0,794	1

PO

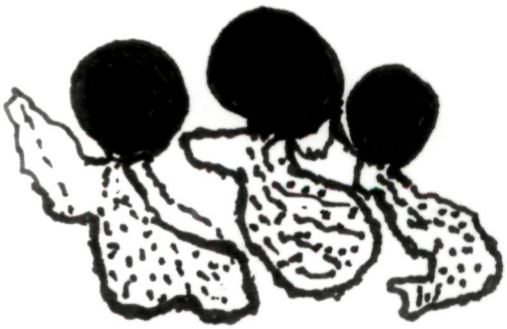
	E.P/Seg	E.H/Seg	I.H/Seg	V/Seg	A/Seg	%Inf/Seg
E.P/Seg	1					
E.H/Seg	0,123073	1				
I.H/Seg	0,093887	-0,31905	1			
V/Seg	-0,82805	0,112873	0,328003	1		
A/Seg	-0,72807	-0,74096	0,080316	0,439301	1	
%Inf/Seg	-0,69761	0,503782	-0,63479	0,499219	0,136402	1

Plate-8:- Showing individual VAM spores

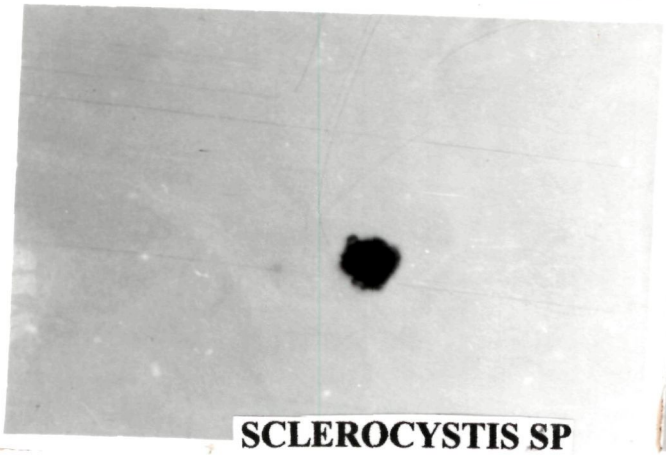


GLOMUS SP

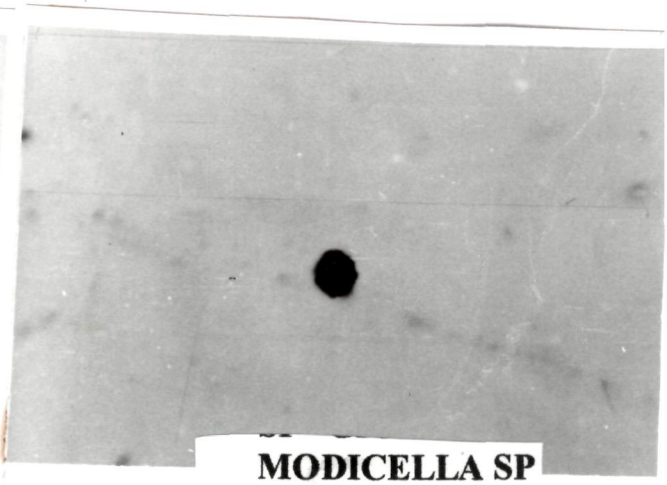
GIGASPORA SP



ACAULOSPORA SP



SCLEROCYSTIS SP



MODICELLA SP

PLATE –8

Results

It was observed that the VAM hyphal biomass was highest (0.140± 0.001-0.201±0.001 micro g /g dry soil) in valley practice followed by moderate quantity (0.100–0.130 micro g /g dry soil) in terrace practice and the jhum practice exhibited least hyphal biomass (0.010-0.060 micro g /g dry soil) in both the years,whereas in jhum practice, the hyphal biomass declined tremendously from Mar-May (0.020-0.030 micro g /g dry soil) and also Nov-Dec (0.020- 0.030 micro g /g dry soil) in both the years (Fig-2).

It was observed that VAM fungal spores (Plate-4) were highest in valley practice in almost all the months, starting from Jan-Dec i.e 24.500±0.015 /g dry rhizosphere soil. The most dominant species observed was *Glomus sp*.i.e.4.023±0.015 spores /g dry rhizosphere soil followed by *Sclerocystis sp* and *Modicella sp*. In terrace practice the number of VAM spores was present in moderate number than valley practice in all the months i.e. 12.802±0.015 spores /g dry rhizosphere soil and in jhum practice the VAM spores were quite less in number than valley and terrace practices in all the months i.e.2.806±0.05 spores / g dry rhizosphere soil and it was observed that from Apr-Jun the spore number dropped down to 2.012±0.05 spores / g dry rhizospheric soil of three agricultural practices. In both the years spore population showed little variation (Fig-3).

The collected earthworms were identified as *Drawida papillifer papillifer* in (valley practice) , *Drawida papillifer papillifer* (terrace practice) and *Tonoscolex horai*, *Drawida assamensis gates* (jhum practice). In earthworm cast the VAM fungal population was found to be highest in valley practice both the years 1996 and 1997 i.e. 14.629±0.015 spores / g dry casts followed by moderate number of spores in terrace

practice i.e. 12.001±0.025 spores / g dry casts and the least number of spores were observed in jhum practice i.e. 5.010±0.045 spores /g dry casts however, the spore number declined to a great extent from Apr-Jun i.e. 2.022±0.035 /g casts and the *Glomus sp* was found to be the most dominant species followed by *Sclerocystis* and *Modicella species* (Fig-3). In earthworm gut content the VAM fungal spores were highest in summer season (Mar-Jun) i.e. 4.001±0.015 spores /g dry gut content in valley followed by terrace practice, whereas, in jhum practice the least number of spore numbers were seen i.e. 2.080 ± 0.05 spores /g dry gut content in all the months of observation,however,during Oct-Feb the spore number dropped down i.e. 2.800± 0.015 spores / g dry gut content (Fig-3). It was also observed that the VAM infection level i.e. (numbers of external hyphae, internal hyphae, vesicles, arbuscules and % infection)(Plate-5) was highest in valley practice in all the three crops i.e. potato, paddy and maize. starting from Mar-Nov and from Dec-Feb the infection level declined. The infection level was higher in summer season i.e. Mar-May than in winter season i.e.Dec-Feb in all the three crops.

In terrace practice moderate percentage infection level(Plate-6) was observed in all the three crops as compared to valley and jhum practices in both the years i.e. 1996 and 1997 (Table:-1-6). The least % infection (28.019-42.102) was observed in winter i.e Nov-Dec and highest % infection (33.023-48.817) was observed in summer season i.e.Apr-May (33.023-48.817) , whereas in jhum practice, the percentage infection level was least than valley and terrace practices. From Apr-Jun the percentage(%)infection (12.234-15.210) level in three crops declined followed by higher level of % infection (26.034-38.032) in three crops in rest of the months (Table-5 and 6). It was observed that right after the sowing of seeds i.e., in a week the

VAM infection level was nil in all the three crops, whereas after a week infection started quickly in all the crops in various sowing periods and in valley and terrace practices the infection process was seen from 8-30 days in a mild rate , whereas after one month till 60 days the infection level was highest and right before the harvesting infection level was constant like before and in jhum practice the infection started after 10 days of showing seeds and was quite slow as compared to valley and terrace practices. It was clearly observed in jhum practice during the month of Apr i.e., right after burning of vegetation the infection level were nil only with few entry points, and during Jan to Feb also the infection process was slow. Same level of slow infection process was observed in valley and terrace practices during Jan to Feb with few entry points. (Table:- 5-6).

It was found that from the statistical calculation when VAM spore number increases the infection level also increases and vice- versa . In potato crops it was seen during the month of Jan to Feb the entry points were negatively correlated followed by external hyphae, internal hyphae, vesicles, arbuscles during winter seasons in valley and terrace practices. In Jhum practice starting from Apr to May same correlation was observed. And for maize and paddy crops in valley and terrace practices, the correlation was positive . It was found that the infection levels i.e number of external hyphae, internal hyphae, entry points , vesicles, arbuscules and % infections in three different agricultural practices and in three different crops were mostly positively correlated (Table- 7 , 8 and 9) may be due to the active hyphal growth and suitable edaphic conditions and climatic factors.

Discussion

According to the experimental observation the VAM status i.e.total spore population (Plate-4) and infection level was highest in valley practice than terrace and jhum practices . This may be due to the suitable temperature, pH, relative humidity and nutrient level of the soil (Clapp *et al* , 1995) and also presumably on account of contact with the previous infective hyphae in the crop fields. In terrace practice, the status of VAM was moderate as compared to valley practice which is due to low pH, nutrient level and high bulk density of the soil (Abbott *et al.*, 1984) and also due to high compaction of soil structure (Nadian *et al.*, 1996). whereas in jhum practice, the VAM status was very low as to compared to valley and terrace practices which is due to low moisture content of soil, acidic pH and burning of vegetations for jhum cultivation (Srivastava and Singh, 1991).In all the three agricultural practices it was found that *Glomus* species population was dominated by least number of *Sclerocystis* and *Modicella* species population , this may be due to the edaphic factors of soil and their individualistic competitive ability (Johnson *et.al* . , 1990), whereas in jhum practice during the month of Mar -Apr the least spore population was observed which may be due to the burning of vegetations for traditional shifting cultivation by farmers (Mc gee *et* . *al* . , 1996). In rhizospheric , earthworm casts and gut contents it was found starting from Oct-Feb the *Sclerocystis* and *Modicella* species population was very less may be due to extreme cold temperature (below1-3^{0}c) and also due to their less competitive ability (Vogelzag *et al* . , 1993) . The VAM infection (%) level was found to be highest in valley practice (33.023-48.817) in all the three crops during summer season i.e (Mar-May) than winter season (Dec-Feb) followed by moderate infection (%) level (28.019-42.102) in terrace practice and jhum practice exhibited least

infection (%) during study periods may be due to the variation in all-round edaphic factors in three different agricultural fields (Abbott *et. al* . , 1984) and also due to indirect effect of altitude on crop plants (Walker *et.al* . , 1996 and Read *et. al* . , 1976) (Tables: - 1-6). It was observed that the hyphal biomass and overall status of VAM (spore population and infection level) was always more in Valley and Terrace practices than in Jhum practice may be due to suitable climatic and edaphic situations (John and Rangarajan, 2001).

CHAPTER-II

Diversity of VAM fungi under different agricultural practices.

Introduction

The diversity of VAM fungi is seen in shifting cultivation (Mcgee *et al.*, 1996), when the soil is disturbed by fire, and physical and chemical weathering (Jasper and Robson, 1989). In some ecosystems like seasonally dry climates, roots in the surface soil show very few number of VAM spores (Jasper *et al.*, 1987). Certain hypothesis show that hyphae of VAM fungi in dry soil remain infective, even after separation from the host root, but this infectivity gets lost and the spore numbers also decrease when the soil is disturbed (Abbott and Robson ,1989). It is also observed that ecological parameters like pH, moisture content and soil temperature cause more unequal distribution of VAM fungal spores in earthworm cultured and non-cultured areas (De Boer *et al*, 1982)., Soil aeration and oxygen concentration bring down the VAM fungal population to a great extent (Nadian *et al*, 1996). The VAM fungal species show uneven distribution of species in different agricultural practices due to soil disturbance (Abbott and Robson, 1991), climatic variance and seasonal changes (Bomke *et al.*, 1991) nutrient level, altitudinal variation (Walke *et al.*, 1990) and genetic diversity in natural ecosystems (Wiermkan and Sanders., 1996).

Materials and Methods

Isolation of endogonaceous spores for estimation of VAM spore diversity.

Isolation of endogonaceous spores for mycorrhizal fungal diversity of three selected agricultural practices was done by wet sieving and decanting method of Gerdeman and

Nicolson (1963). 5 g of rhizoheric soil, 5 g cast soil and 1g gut soil were stirred separately in 500 ml beaker containing 500 ml distilled water for 30 minutes, allowed to sottle down the heavier soil particles, spores being lighter float over water surface, Spores were then separated from soil by decanting and subsequently by passing through the sieves of 200, 150, 90, 50 micron sizes. The retained spores on sieves were washed under tap water to remove any soil particles and organic debris. Then the spores were collected separately, filtered through whatman No-1 filter paper and counted . They were later identified under binocular stereo microscope. Identification of VAM spores were done by Trappe and Schenck (1984) method.

Fig-4 & 5 :- Total number of individual VAM spore population in rhizospheric soil of valley,terrace and jhum practices.

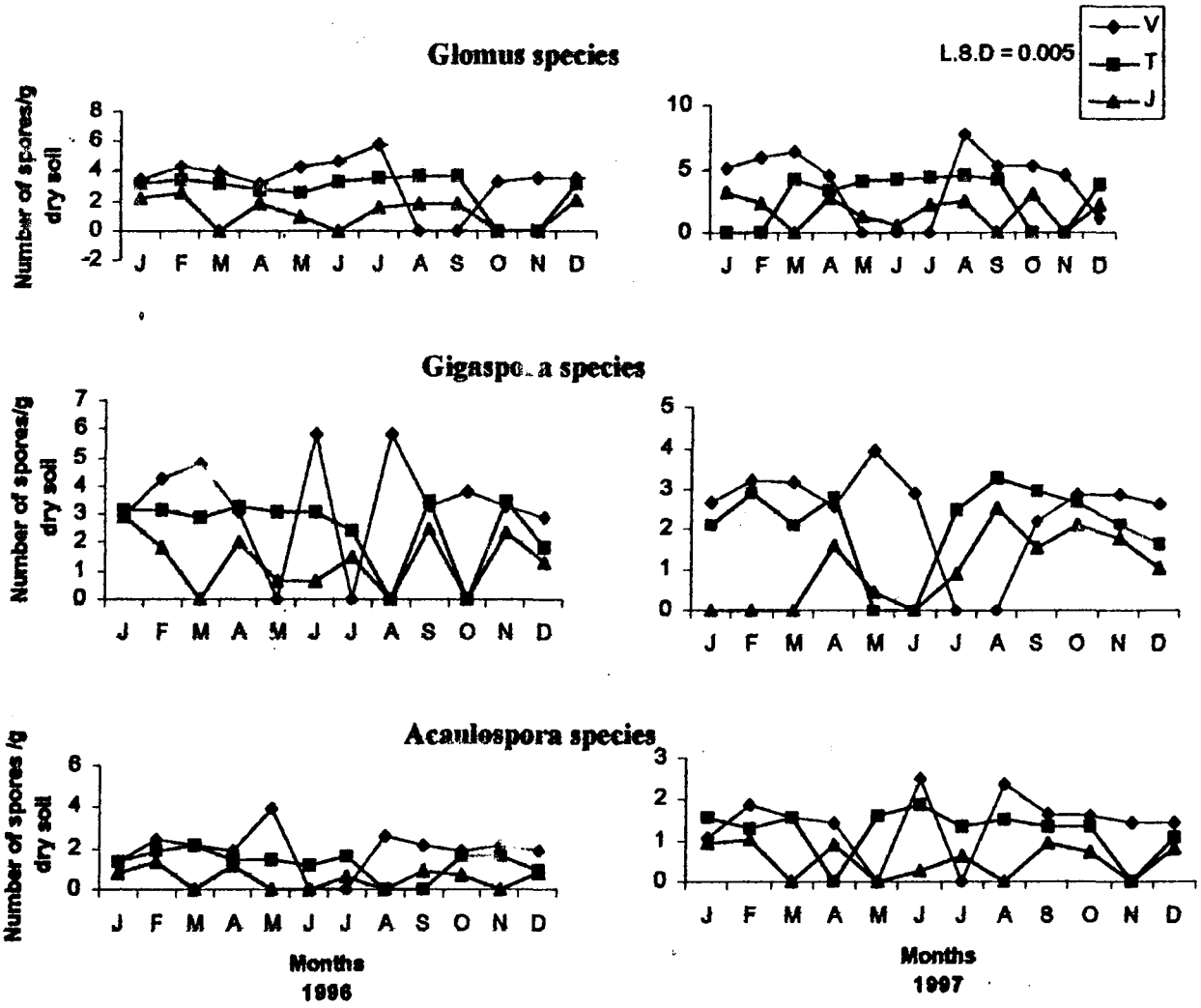
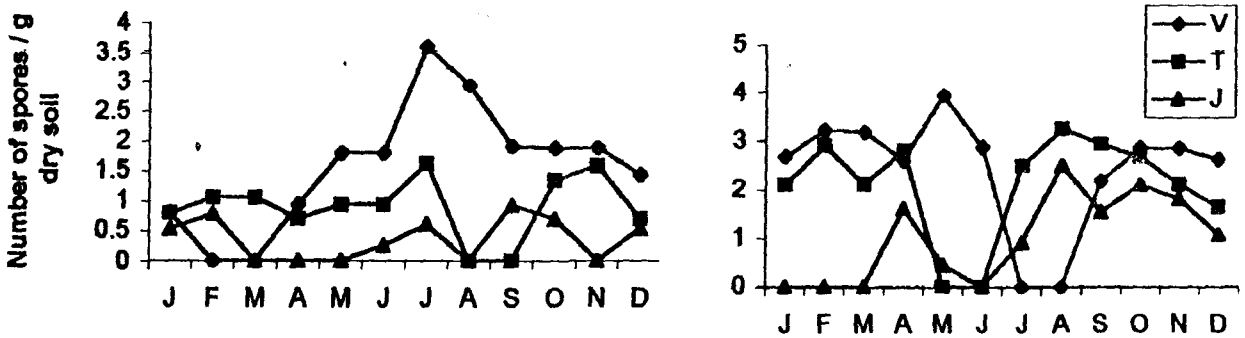


Fig-4

Sclerocystis species



Modicella species

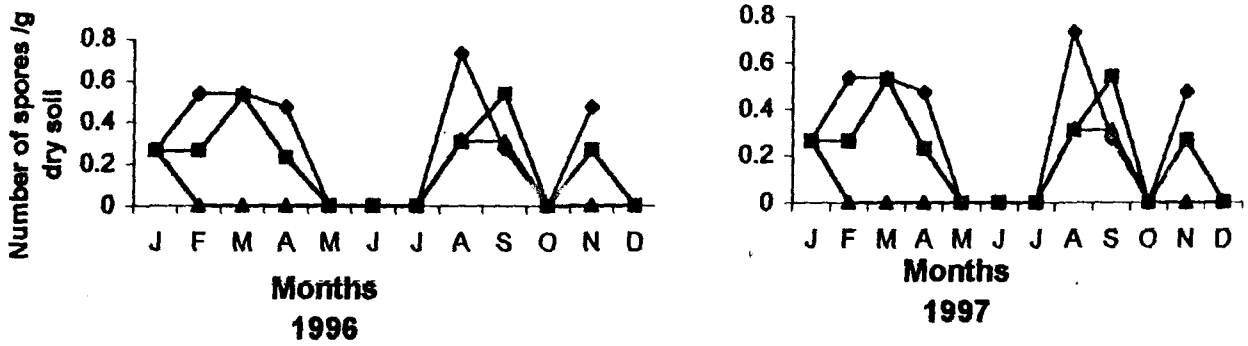


Fig-5

Fig-6&7 :- Total number of individual VAM spore population in cast soil of valley,terrace and jhum practices.

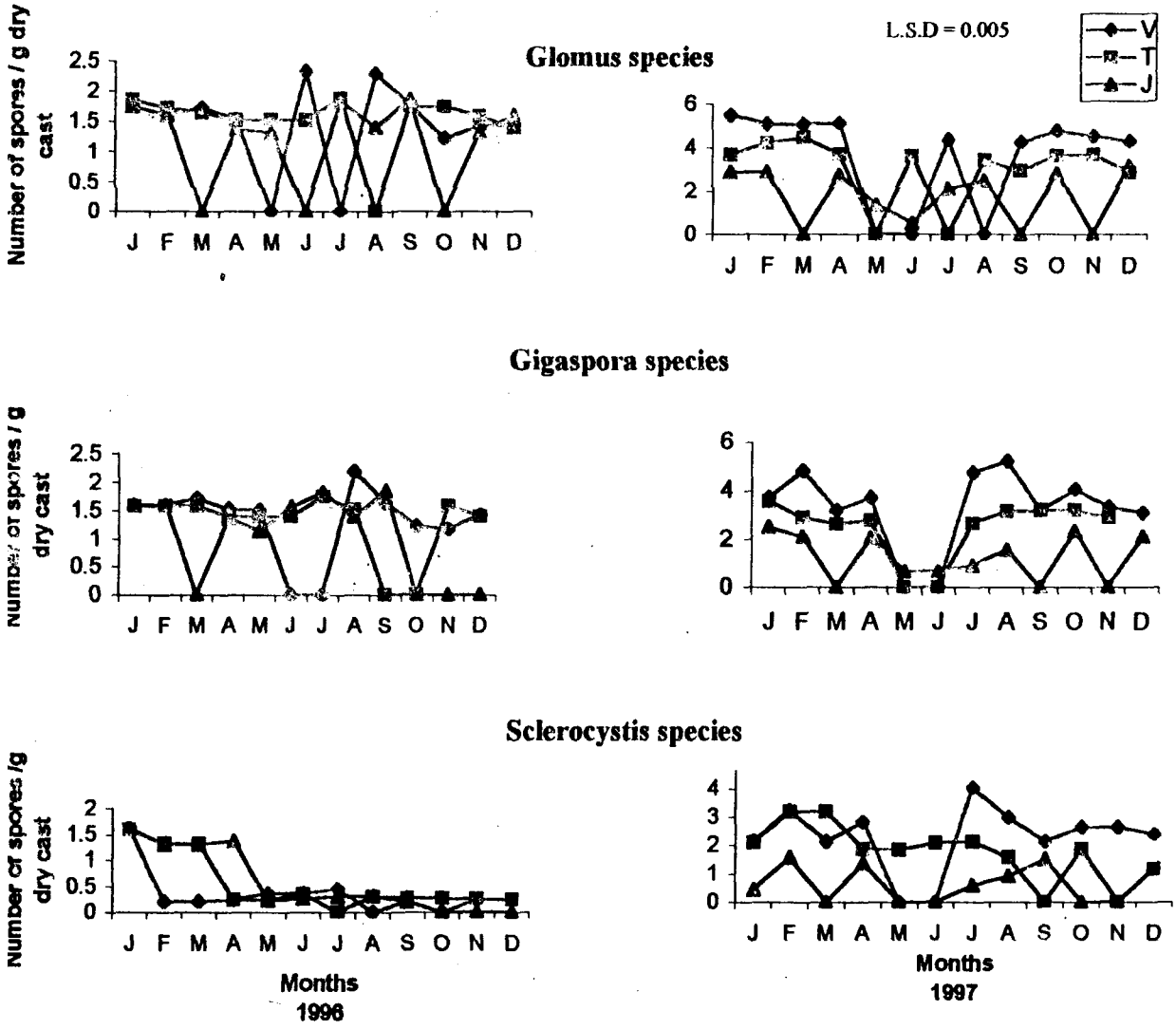
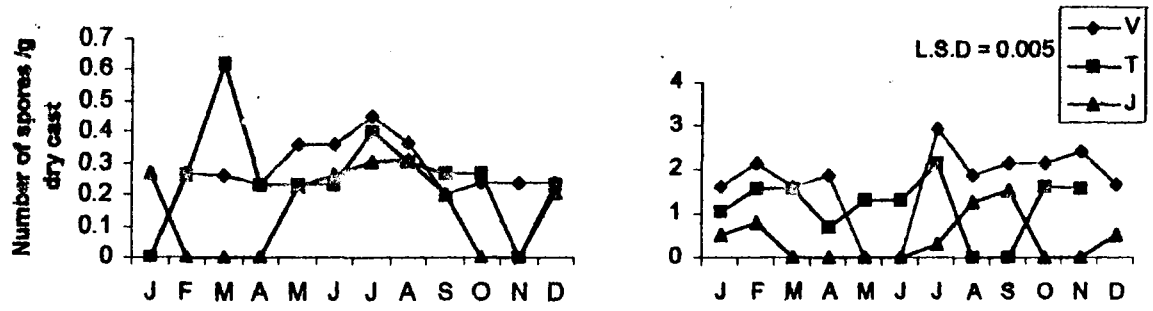


Fig-6

Sclerocystis species



Modicella species

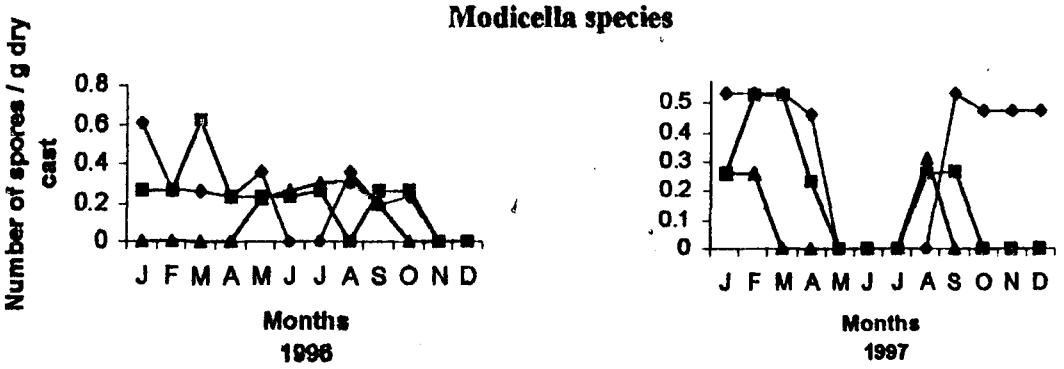


Fig - 7

Fig-8&9 :- Total number of individual VAM spore population in gut content of valley,terrace and jhum practices.

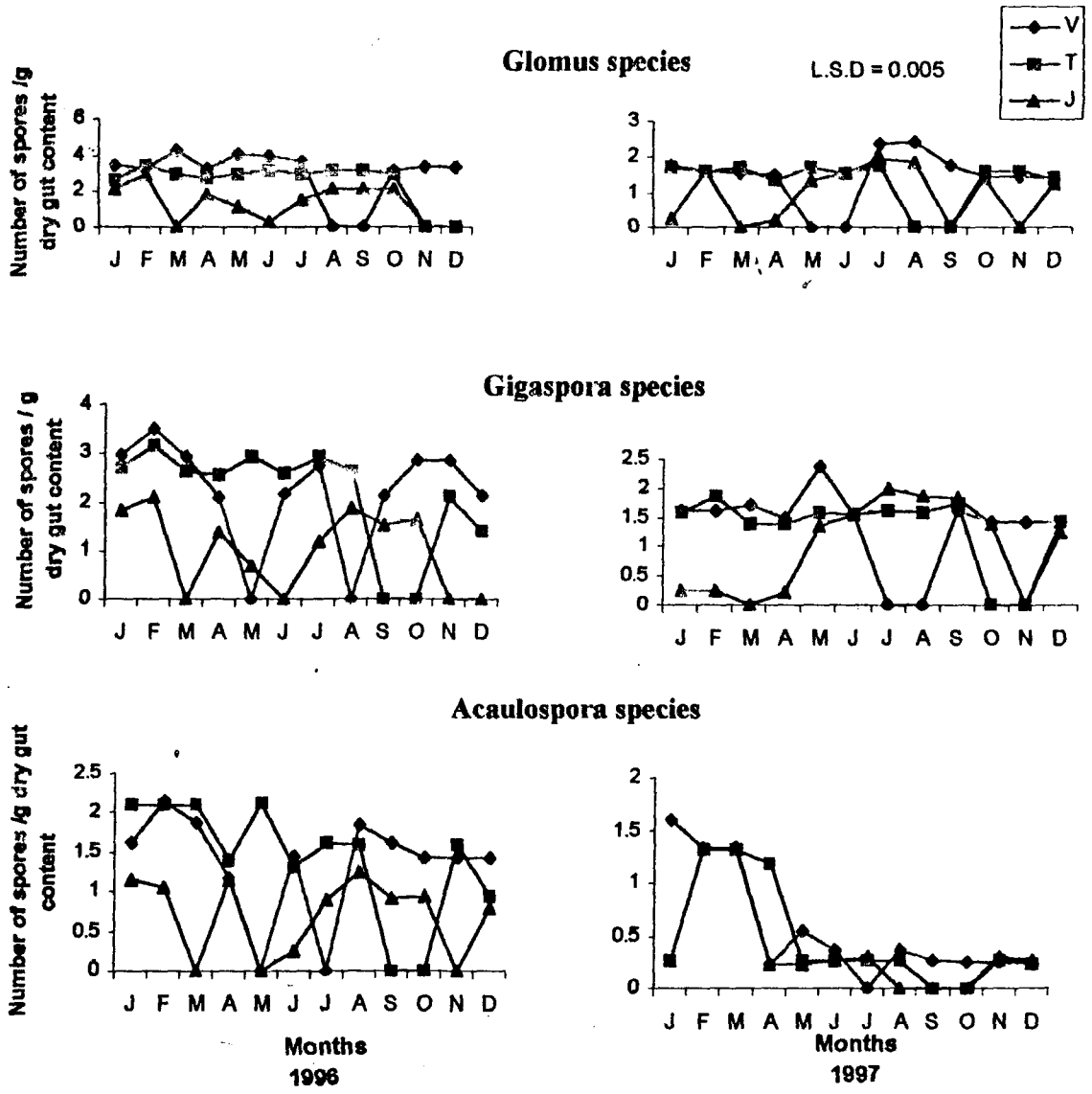


Fig- 8

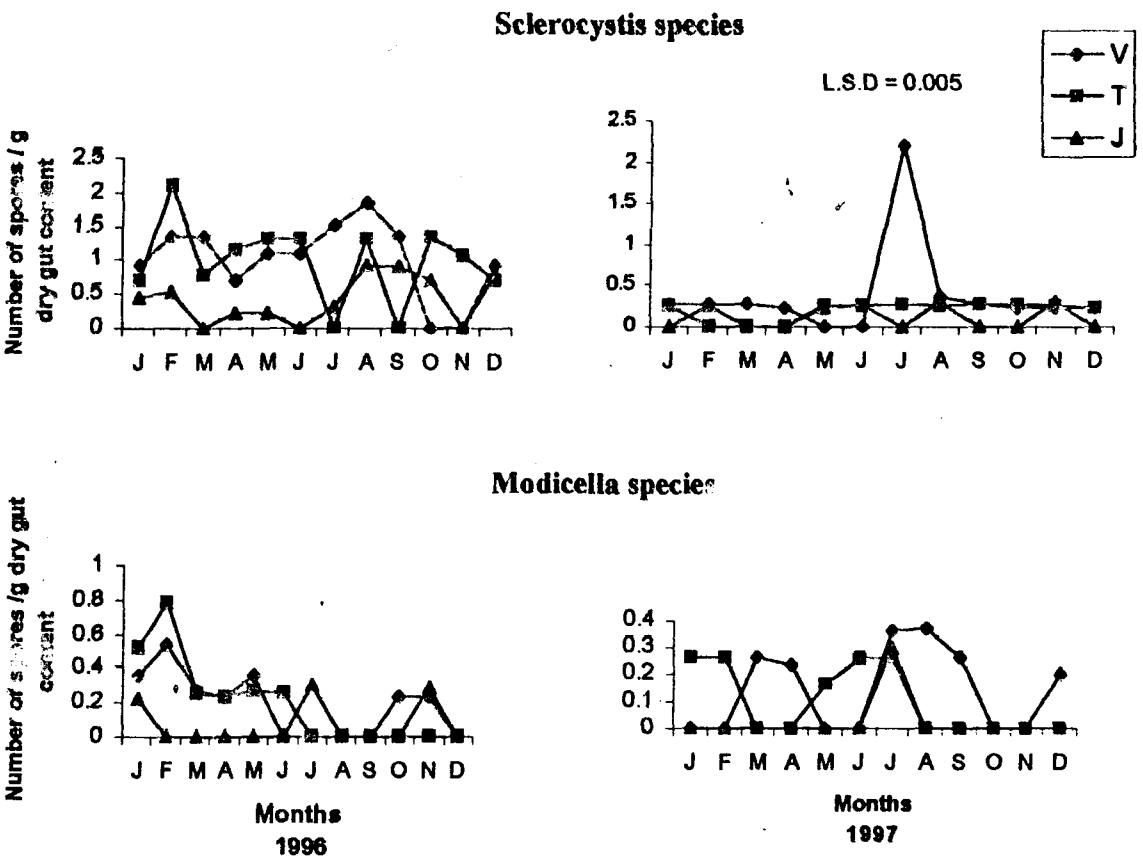

Sclerocystis species
L.S.D = 0.005
V
T
J
Number of spores / g dry gut content
2.5
2
1.5
1
0.5
0
J F M A M J J A S O N D
Modicella species
Number of spores /g dry gut content
1
0.8
0.6
0.4
0.2
0
0.4
0.3
0.2
0.1
Months
1996
Months
1997

Fig -9

Table- 9 (a):- Diversity index values of VAM spores / g dry soil in valley , terrace and jhum practices .

MONTHS	V	V	T	T	J	J
	1996	1997	1996	1997	1996	1997
J	0.926	1.415	0.014	2.386	0.232	1.496
F	1.995	1.027	0.141	0.172	0.042	0.112
M	0	0	0		0	0
A	0.026	0.089	0.321	0.120	0.086	0.119
M	0.096	0.196	0.823±.001	0.728±0.001	0.668±0.001	0.116
J	0.525±.001	0.597	0.830	0.520	1.006	0.118
J	0.096	0.896	0.592	0.662±.001	0.896±.001	0.558±0.001
A	0.328	0.956±0.001	0.862±0.001	0.566	0.066	0.862±0.001
S	0.528±.001	0.927±0.001	0.577±.0001	0.866	0.966±0.001	0.727
O	0.326	0.526	0.907	0.800±0.001	0.727	0.806±0.001
N	0.520	0.760±0.001	0.809	0.026	0.029	0.112
D	0.066±0.001	0.088	0.006	0.866	0.526	0.520

V- Valley practice , T – Terrace practice , J- Jhum practice. ± :- Standard error

Table- 9 (b):- Diversity index values of VAM spores / g dry cast in valley , terrace and jhum practices .

	V	V	T	T	J	J
MONTHS	1996	1997	1996	1997	1996	1997
J	0.232	0.752	0.866	0.623	0.529	
F	0.862	0.532	0.966	0.528	0.524	0.662±0.001
M	0	0	0	0	0	0
A	0.877	0.776	0.667±0.001	0.662	0.661±0.001	0.661
M	0.527±0.001	0.826±0.001	0.526	0.962±0.001	0.656±0.001	0.116
J	0.923±0.001	0.503	0.506±0.001	0.702±0.001	0.908±0.001	0.666±0.001
J	0.028	0.029±0.001	0.055	0.066	0.866±0.001	0.566±0.001
A	0.206±0.001	0.702	0.806±0.001	0.506	0.113	0.522
S	0.606	0.608±0.001	0.703	0.708±0.001	0.616	0.105
O	0.021	0.051±0.001	0.066	0.098	0.011	0.166
N	0.072	0.031	0.051	0.098	0.006	0.009
D	0.081±0.001	0.083	0.073	0.059	0.098	0.066

V- Valley practice , T – Terrace practice , J- Jhum practice. ± :- Standard error

Table- 9 (c):- Diversity index values of VAM spores / g dry gut content in valley , terrace and jhum practices .

	V	V	T	T	J	J
MONTHS	1996	1997	1996	1997	1996	1997
J	1.021	0.078	0.066	0.090	0.089	0.866
F	0.066	0.072	0.115±0.002	0.117±0.002	0.070	0.978±0.002
M	0	0	0	0	0	0
A	0.727	0.566	0.773	0.728	0.887	0.662±0.002
M	0.028±0.002	0.726	0.057	0.098	0.557	0.072±0.002
J	0.092±0.002	0.036±0.002	0.082±0.002	0.098±0.002	0.066	0.067
J	0.083±0.002	0.066±0.002	0.072	0.086	0.052	0.171
A	0.081	0.092±0.002	0.092±0.002	0.081	0.116	0.113±0.002
S	0.552	0.072±0.002	0.770±0.002	0.273±0.002	0.728	0.379±0.002
O	0.011	0.556±0.002	0.066	0.022	0.056	0.027±0.002
N	0.066±0.002	0.087±0.002	0.091	0.072	0.052	0.098
D	0.066±0.002	0.092	0.066	0.076	0.089	0.098

V- Valley practice , T – Terrace practice , J- Jhum practice. ± :- Standard error.

Results

It was observed that the VAM fungal diversity was differentiable in valley, terrace and jhum practices according to the diversity index table (Table 9:-a,b,c). In valley practice *Glomus sp* was dominant i.e. 8.423 spores / g rhizospheric soil and the second dominant sp was *Gigaspora sp* i.e.5.801 spores / g rhizospheric soil and the third species was *Acaulospora sp* i.e.3.401spores / g rhizospheric soil, whereas the number of *Sclerocystis sp* was 2.200 spores / g rhizospheric soil and the most recessive sp was *Modicella sp* i.e. 0.400 spores / g rhizospheric soil. During summer season (Apr-Jun) the *Modicella sp* was absent in terrace practice, the most dominant sp was *Glomus sp* i.e.6.200 spores/ g rhizospheric soil, the second dominant sp was *Gigaspora* sp i.e 4.400 spores / g rhizospheric soil, and the *Acaulospora sp* number was 2.212 spores / g rhizospheric soil followed by the least number of *Sclerocystis sp* i.e.1.212 spores / g rhizospheric soil and the number of *Modicella sp* was 0.401spores / g rhizospheric soil (Fig-4&5). It was observed that in jhum practice from Apr-Jun the *Sclerocystis sp* and *Modicella sp* were absent. The most dominant *Glomus sp* i.e.3.000 spores / g rhizospeheric soil and from Mar-Jun almost all the mycorrhizal spore number declined i.e. 3.201 spores / g rhizospreric soil (Individual spore population).(Plate-5) It was also found that from Nov-Feb the spore number was very low i.e.5.123 spores /g rhizospheric soil, whereas the spore population did not fluctuate much from Jun-Oct (Fig-4&5). TheVAM fungal diversity was also observed in casts, where the dominant species was *Glomus sp* i.e 6.001 spores / g cast, followed by *Gigaspora sp* i.e 3.801 spores / g cast soil and least number of *Sclerocystis sp* i.e.2.402 spores / g casts and *Modicella sp* i.e.1.634

spores / g cast soil were recorded in 24 months observation of valley and terrace agricultural practices, whereas in jhum practice the most dominant sp was *Glomus sp* i.e.3.020 spores / g casts, the second dominant sp was *Gigaspora sp* i.e.2.012 spores / g casts followed by least number of *Sclerocystis sp* i.e.2.000 spores / g casts and *Modicella sp* 0.400 spores / g casts in 24 months observation and in jhum practice, during the month of Mar the spore population were completely absent (Fig-6&7).It was observed that starting from May-Aug the number of *Glomus* species were (2.090-2.915)/ g dry gut content in valley practice followed by least number of all other species in rest of the months i.e (0.213-1.513) , whereas in terrace practice the individual spores were moderate in number / g dry gut content and jhum practice showed least number of spores than valley and terrace practices (Figs-8 and 9). It was also remarkably seen that in the month of Mar the number of individual spores were completely absent . (Figs-8 and 9).It was found from diversity index Tables – 9 (a) , 9 (b) and 9 (c) that in three different agricultural practices and in three different soil conditions i.e dry rhizospheric soil , cast soil and gut content *Sclerocystis* and *Modicella sp* were less in number than other species.

Discussion

According to the observation it is clear that in valley practice both in rhizospheric soil and earthworm cast soil, the individual VAM fungal spore population were highest , this may be due to suitable temperature, soil pH, nutrient level, regular cultivation and moisture content of soil (Clapp *et al.*,1995) (Figs-4&5). In terrace practice the mycorrhizal spore population were moderate as compared to valley practice which may be due to low soil pH, high bulk density, low soil moisture content and sloppy land (Abbott *et al.*, 1984). It was found that in all the three agricultural practices *Glomus sp* was dominant sp than *Sclerocystis*

and *Modicella sp* . This may be due to the edaphic factors of the soil and their individualistic competitive ability (Johnson *et al.*,1990).Whereas in jhum practice during the month of Mar-Apr the least spore population was observed which may be due to the burning of vegetations for traditional shifting cultivation by farmers (Mcgee *et al*, 1996). It was observed that in both rhizospheric soil and earthworm casts starting from Oct-Feb the number of *Sclerocystis* and *Modicella sp* were very less may be due to extreme cold temperature (below 1-3^{0}C) and due to their less competitive ability (Vogelzag *et al.*,1993). In jhum practice the spore population declined in all the 24 months as compared to valley and terrace practices, which may be due to acidic pH of soil (4.70-4.71) and burning of vegetation (Skipper and Smith.,1979). The diversity seen from the diversity index tables in three agricultural practices may be due to the climatic, ecological and altitudinal variations in valley (1000m.s.l), terrace (1100m.s.l.), jhum (1600.25 m.s..l) (Saif *et al.*,1983) . The low number of *Sclerocystis sp and Modicella sp* observed during the months of Oct-Feb in both the rhizospheric soil and the earthworm casts may be due to extreme cold temperature (below 1-3^{0}C) and also due to their less competitive ability (Vogelzag *et. al.*,1993). In jhum practice during the month of Mar-Apr the least spore population was observed may be due to the edaphic factors of the soil and their individualistic competitive ability (Johnson *et al.*,1990) and also may be due to the burning of vegetations for traditional shifting cultivation by farmers (Mcgee *et al.*,1996). From the diversity index Table:-9(a),9(b) and 9(c) it was seen that *Sclerocystis* and *Modicella sp*. were least in number and more than index value may be due to the influence of other dominant spores.

CHAPTER –III

Physico-chemical properties of soil under different agricultural practices

Introduction

The growth and development of VAM fungi are affected by many climatic and ecological factors (Saif . ,1984). Generally physico- chemical properties of soil include pH, moisture content , organic matter (C), bulk density of soil and other essential elements like C, H, O, N, P, K, S, Ca , Fe, and Mg , which have direct and indirect effect on crop plants through different VAM fungi (Johansen *et al.*,1993). The absorption and translocation of nutrients like N, P, K, and other micro- nutrients from soil through root hairs and mycorrhizal associations to the different parts of the crop plants (Ibijibijen and Urquiaga ,1996) depend mostly on the physico-chemical properties of soil (Jensen - -.,1982). It has been seen that both bulk density, porosity and particle fractionation plays a very vital role in soil for VAM fungal sp. for easy translocation of water and mineral nutrients (Jones *et al.*,1970). Organic matter (C) can be said to be very important in each and every way that organic compounds are the important constituents of plant structure, protoplasm and enzymes. This can be easily transferred from root to the shoot parts by VAM fungus by fungal biomass in agricultural fields (Dalal and Henderson ,1991). Nitrogen is also very important constituents of amino-acids, and enzymes, which can be easily transferred by external hyphae of VAM fungus i.e *G.intradices* (Johansen *et al.*,1996).Phosphorus is also a constituent of many compounds in plants i. e A.T.P, NADP, pyridoxal phosphate a co-enzyme can easily assimilated by VAM fungal sp. (Scott *et al* . ,1996).from soil to different crop plants , sometimes agricultural practices, high rainfall, and high relative humidity causes soil compaction, which also increase bulk density and alters the porosity, water holding capacity

of the soil (Hoffmann and Jungk ,1995). These properties of soil and climatic factors influence plant growth by mechanical resistance (Bengough and Mullins. ,1991) .

Materials and Methods

For the analysis of physico-chemical properties of soils, the soil samples were collected from three agricultural practices in separate sterilised polythene bags, pH, moisture content, total nitrogen, available phosphorus, available potassium, organic carbon and bulk density of collected soil were determined as follows :-.

Determination of soil pH : -

10 g of soil was taken in 50 ml of distilled water stirred for 15 minutes on a magnetic stirrer and pH of the solution was read by a digital pH meter.

Determination of % Moisture content of soil : -

10 g of soil was taken in three replicates , kept in a hot air oven at 100^0C and weighed till a constant weight was obtained . The percent moisture content was calculated as follows : -

$$\text{Percent moisture content} = \frac{\text{intitial wt - final wt}}{\text{initial wt}} X100$$

Bulk density of soil : -

The volume and the mass of the soil sample after drying was taken for the measurement of bulk density by following formula

$$\text{Bulk density} = \frac{\text{Mass of soil after drying}}{\text{Total volume of soil}}$$

Determination of total soil Nitrogen :-(Semi-micro Kjeldahl method).(Allen, 1974).

Procedure:-1 g of sieved soil sample was taken into a 50 ml of round bottomed Kjeldahl flask, to it 2g of K_2SO_4-HgO mixture, and 3ml of conc. H_2SO_4 were added and kept in the digestion rack till a pale green colour develops. Then it was allowed to cool and diluted with 50 ml of water and filtered the digest. After filtration the solution was distilled with 40 % NaOH . The released ammonia was absorbed in 4 % boric acid and treated with 1N HCL. The blank digest was prepared with reagents only.

Calculation :-

T= ml/140Hcl used for titration

$$N(\%) = \frac{T(ml) \times \text{solution volume (ml)}}{10^2 \times \text{aliquot (ml)} \times \text{sample weight (mg)}}$$

Determination of available Phosphorus :- (Allen , 1974)

For the determination of available phosphorus Molybdenum blue method was followed. The available phosphorus was extracted in 0.002 N H_2SO_4.1 g air dried sieved soil was taken in a 250 ml conical flask and to it 100 ml of extract solution was added and was stirred for 30 minutes, and filtered through Whatman No-42 filter paper. 3 ml of aliquot was pipetted out in a 50 ml volumetric flask and 2-3 drops of dinitrophenyl indicator was added to the aliquot. Then 2 ml of sulpfomolybdic acid was added. The flask was shaken for a while and then 0.5 ml of chlorostannous acid was added and the volume was made to 50 ml .The

absorbance of the solution was taken in spectrophotometer at 700 nm. The concentration of phosphorus was calculated with the help of standard curve by the following formula

Calculation:-

C = mg (P) obtained from the graph

$$\text{Available P (\%)} = \frac{\text{C (mg)} \times \text{solution volume (ml)}}{10 \times \text{aliquot (ml)} \times \text{sample wt (g)}}$$

Determination of available Potassium : -(Allen,1974)

Potassium was extracted in ammonium acetate solution , which was prepared by mixing 575 ml of glacial acetic acid with 600 ml of ammonia solution and diluted to 10 litres with distilled water. The pH of the solution was adjusted to 7.0±0.05 with the help of acetic acid and ammonia solution . 1 g of sieved soil was added to 125 ml of extraction soln. and was stirred constantly for one hour and filtered through Whatman-44 filter paper. The required potassium was read through flame photometer and converted into known unit through standard graph and calculated by following formula.

Calculation:- C = mg K obtained from graph.

$$\text{Available K (\%)} = \frac{\text{C (mg)} \times \text{solution volume (ml)}}{10^4 \times \text{sample aliquot (g)}}$$

Determination of Organic Carbon:-

The rapid titration method of Walkey and Black (1934) was followed for the determination of organic carbon. 1 g air dried sieved soil was taken in a dry and cleaned 500 ml conical flask along with 10 ml of 1 N $K_2Cr_2O_7$ and 20 ml of conc.H_2SO_4 .The flask was not disturbed for 30 minutes. To this , 10 ml of 85 % phosphoric acid was added and titrated with 1 N $FeSO_4$ solution with diphynylamine indicator. For blank (without sample) same procedure was followed . Three replicates were maintained in all the cases. The organic carbon was determined as follows:-

Calculation:- If 'T ml of 0.4 M Ferrous ammonium sulphate are used in the titration then:-

$$\text{Organic Carbon (\%)} = \frac{(27.5 - T)\text{ml} \times 0.12}{\text{sample weight (g)}}$$

Fig-10 Physical properties (pH, moisture content and bulk density) of valley, terrace and jhum practice soil.

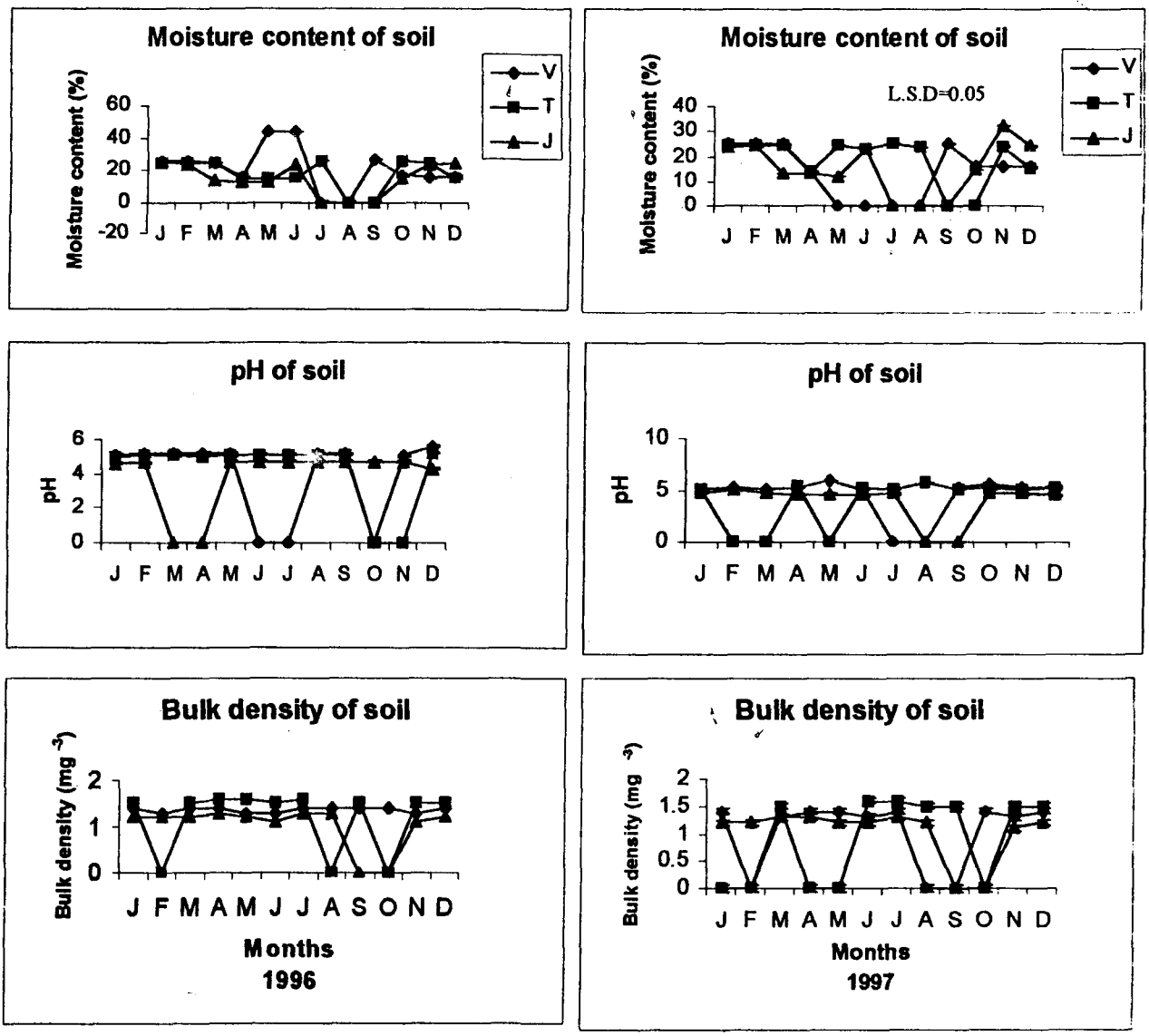
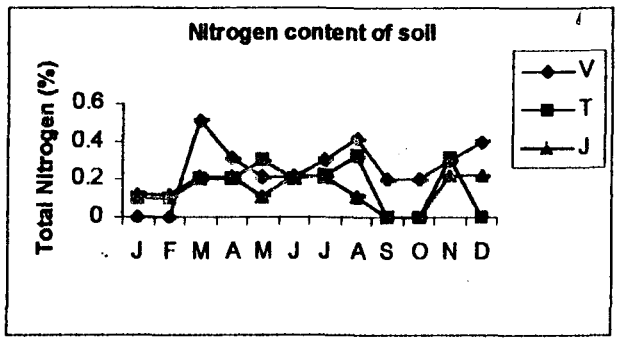
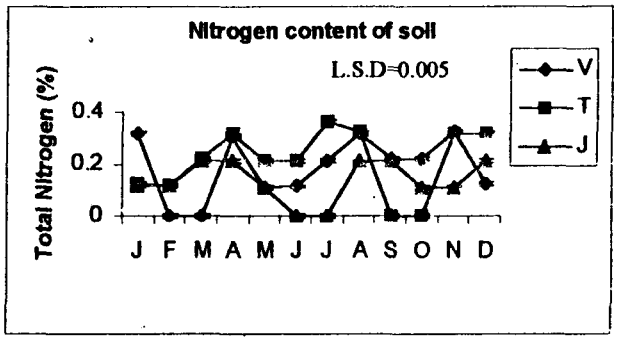
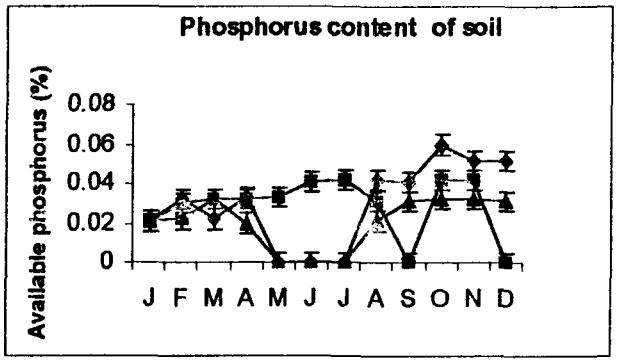
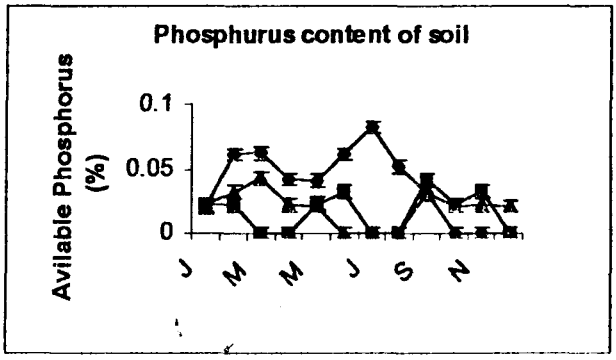


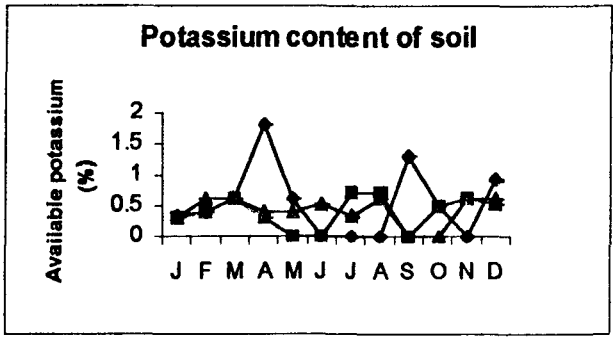
Fig-11:- Chemical properties (Total nitrogen, available phosphorus, available potassium and organic carbon) of valley, terrace and jhum practice soil.

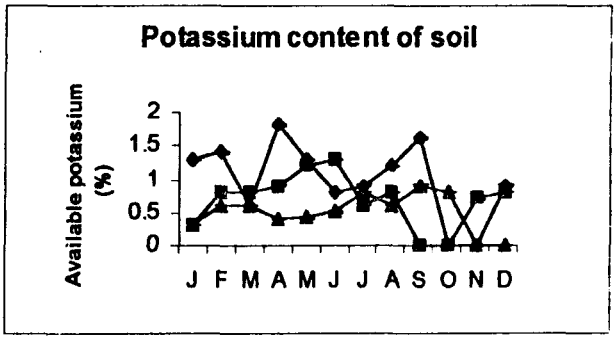


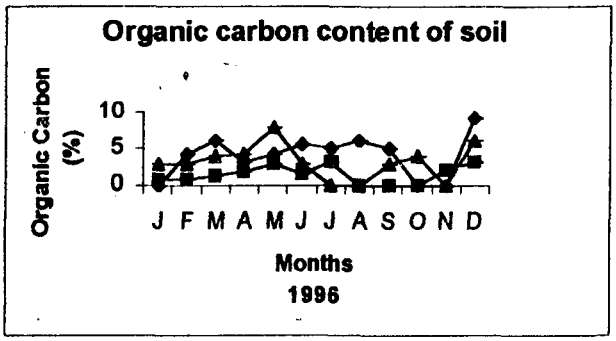


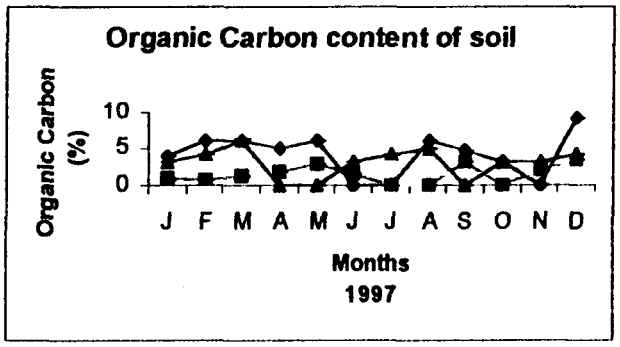












Results

It was observed that the moisture content (%) from Mar-Jun ranged from 15.012 ±0.015 - 44.037 ±0.015 in valley practice , 14.980 ±0.015 - 24.864 ±0.015 in terrace practice and 12.012 ±0.025-13.057 ±0.025 in jhum practice and from Jul-Dec the moisture content (%) was 16.971±0.035 - 55.981 ±0.035 in valley practice 25.861 ±0.065 - 34.871±0.065 in terrace practice and 14.065±0.025 – 34.085±0.025 in jhum practice , whereas from Jan-Feb the moisture content (%) remained moderate in all the three agricultural practices i.e Valley (24.001±0.015–25.012±0 .015), terrace (24.981 ±0.025–25.981±0.025) and jhum (13.001±0.045–25.091±0.045) (Fig-10). It was observed that the soil pH of valley practice was 5.12 ±0.005 – 5.62 ±0.005 in 1996 and 5.02±0.005–5.90±0.005 in 1997, and in terrace practice the pH was 5.03±0.075–5.08 ±0.075 during the month of Jan-May in 1996, whereas the pH range increased up to 5.06±0.005-5.72±0.005 from Jun-Dec in 1997.Whereas in jhum practice the pH range was 4.29±0.005-4.71±0.005 in 1996 and the range became high (4.23±0.025-5.00±0.025) in 1997 (Fig-10). It was observed that the bulk density of the terrace practice was more i.e.(1.5±0.005–1.6±0.005) mg^{-3} and in valley practice was moderate i.e (1.3±0.005–1.4±0.005) mg^{-3} , whereas in jhum practice low bulk density was observed i.e (1.1±0.005-1.3±0.005) mg^{-3} during the study periods.

(Fig-10.

The percentage nitrogen content in valley practice was highest followed by terrace and least in jhum practice. The percentage nitrogen content (Jan-Dec) in valley practice ranged highest followed by terrace and least in jhum practice .The percentage available phosphorus content (Jan-Dec) in valley practice ranged highest followed by terrace and least

in jhum practice ..The available potassium content (Jan-Dec) in valley and terrace practices ranged almost same followed by least in jhum practice , and the percentage organic carbon content (Jan-Dec) in valley practice ranged highest followed by jhum and least in terrace practices. (Fig:-11).

Discussion

In valley practice the percentage moisture content (%) was highest during the month of May-Oct due to heavy rainfall followed by moderate moisture content in terrace practice and least in jhum practice , which may be due to sloppy land which can not hold water for a longer period , whereas the plain valley land can hold water for a longer period in all the three agricultural practices.The low percentage moisture content (%) during Mar-May , may be due to the increase in soil temperature , and due to more evaporation rate than the rest of the months. In valley practice the soil pH ranged highest (Jan-Dec) in both the years may be due to the plain land which can hold the hydrogen ion concentration for a longer period followed by moderate in terrace practice may be due to the sloppy land which washed away the hydrogen ion quickly during heavy rainfall , whereas in jhum practice the soil pH range was least (4.29-4.71) in both the years may be due to sloppy and rocky land which helps in carrying away the hydrogen ions by rainfall and deposits in the adjacent bottom areas.

The highest percentage nitrogen content of valley practice than terrace and jhum practices may be due to the plain land , high decomposition rate of vegetations by microbes , carrying away by heavy rainfall from different adjacent mountains and mineralisation (Singh *et al* . ,1991) , and in terrace practice the percentage nitrogen content was moderate than

valley may be due to sloppy land which deposits part of the nitrogen content in the adjacent bottom areas , whereas in jhum practice the percentage nitrogen content was comparatively less than valley and terrace practices may be due to heavy rainfall which washed away the existing nitrogen and accumulated in the nearest ground level. The low percentage phosphorus content in all the three agricultural practices during study period may be due to uptake by the crop plants in previous harvesting and absence of rainfall , whereas higher percentage during May-Dec may be due to rainfall and carried away by heavy rainfall from the adjacent hills and accumulated in the adjacent plain valley land. In jhum practice the percentage phosphorus content was least than valley and terrace practices may be due to high shower of rainfall, and rocky land which deposited in the adjacent bottom areas . It was also found that the percentage potassium content of both valley and terrace practices were almost similar, whereas in jhum practice the percentage potassium content was least may be due to rocky soil , presence of less vegetation and washing away by heavy rainfall and accumulated in the adjacent low land areas. It was seen that percentage carbon content in jhum practice was highest during the study period than valley and terrace practices may be due to burning of existing and collected vegetations for jhum cultivation by farmers and natural mineralisation process (Robertson , 1983) (Fig-11).

CHAPTER-IV

Role of VAM in nutrient transfer in crop plants under different soil conditions

Introduction

The role of VAM fungi in nutrient uptake in crop plants in pot trials is found to be very effective (Omar, 1996) in different soil conditions , VAM fungi show a very remarkable transfer of nitrogen (Ibijibijen *et al* . ,1996), phosphorus (Tarafdar and Marschner,1994) and potassium (Calmer *et al* . ,1983) . The effect of VAM fungus *Glomus constrictum* on maize plants in pot trials shows remarkable growth (Omar, 1996). Due to burning and grazing in dry soil , for nitrogen mineralisation the VAM fungal species show quick transfer of nutrients in the crops (Singh *et al*. ,1991). It is also seen that VAM fungi induced by certain species of endogone occur in a wide range of plants in different habitats (Nicolson 1959). It has been observed that the agricultural practices cause soil compaction , which increases bulk density and alters indirectly soil pore size , movement of air , water and nutrients (Hoffman and Jungk . ,1995) . Soil properties influence plant growth either by mechanical resistance (Bengough and Mullins.,1991) or by poor aeration (Agnew and Varrow.,1985) . The most important factor is soil 'P'supply, which is negatively correlated with mycorrhizal growth response and with the extent of fungal colonization (Bruce *et.al* . , 1994) . VAM fungi are widely found in field crops and many investigations have described that plant growth may be increased by them (Mosse.,1973) . In short season crops , it seems that a significant effect of VAM fungi on phosphorus uptake and growth of plants must depend on early infection (Tinker and Black,1975) and this is indirectly related to inoculum density (Hayman *et.al* . ,1976) may be for this reason most experiments in which crop growth in the

field has improved inoculation with endophyte , where natural inoculum levels were less following either soil sterilisation (Peacock and McMillan,1975) or previous growth of uninoculated species (Black and Tinker , 1977) .Even if the inoculum density is plenty, presence of high percentage infection may be late , if the root system is extending very first (Sutton ,1973). Mycorrhizal infection may change the phosphorus deficit or phosphorus utilization efficiency independently from its direct effect on phosphorus transfer , making the prediction of response to mycorrhizal infection based on the traits of non-mycorrhizal plants quite difficult , for example infection may at times increase the rate of phosphorus accumulation beyond which can be currently utilised in growth reducing the current phosphorus uptake efficiency (Roger ,1989). The special relationship formed between crop plants and fungus in this association results a high degree of structural, physiological and biochemical integration from which both partners are benefitted (Bago *et al* ,1996) . The physical separation of the macrostructure of a zero tilled soil reduced P absorption by 3 week old maize (*Zea mays L*) plants grown under sterilised conditions. The undisturbed system was found to provide P rich high moisture surface layers in which maize roots spreaded , then it was also found that soil disturbance decreased VAM infection in maize roots . Anderson *et al* . , (1986) observed a higher percentage infection of root sample from zero tilled soil conditions, but again observed that it also increases in P uptake by maize grown in the undisturbed system , for certain species of VAM fungi dried mycorrhizal rootscan act as propagules, such propagules are of major importance in the growth of most agricultural plants. The occurence of viable hyphae in root segments may describe some of the differences between the spore and propagule numbers (Porter,1979). It may also be said that lack of relationship between spore numbers and infection levels developed in crop plants grown in a range of soil (Hayman and Stovold, 1979).

Materials and Methods

For the role of VAM fungi in uptake of nutrients from the soil of three different agricultural practices (valley ,terrace and jhum) to three different crop plants (Potato, Maize, and Paddy), the experiment was conducted in three different fields having 1m length x1m breadth size . The soil was sterilised with 4 % formalin, and in each field 50 sterilised paddy seeds, 20 sterilised maize seeds and 10 sterilised potato seeds were sown separately as well as in combination. In one set of experimental field , seeds were inoculated with 100 number of VAM spores(Y) i.e. *Glomus, Gigaspora and Sclerocystis sp* mixed together . In another set double number (Z) i.e 200 number of mixed VAM spores i.e *Glomus, Gigaspora and Sclerocystis sp* mixed together were inoculated and in the third set in each field no VAM spores were inoculated i.e.(Control-X). Three replicates were maintained for each set. The study was carried out for a period of six months. Samplings were done at 30 days interval . N, P, and K of soil were analysed following semimicro-kjeldahl method (Allen, 1974), molybdenum blue method and flame photometer method respectively . The nutrients i.e.N, P, and K, of three different crops (potato, maize, and paddy) were also analysed at 30 days interval. The total nitrogen of the different crops were analysed by semimicro- kjeldahl method (Allen,1974) total Phosphorus by molybdenum blue method and total potassium by flame photometer method.

Analysis of total plant Nitrogen (Allen , 1974) : -

Procedure :- 1 g of finely ground sample was taken in a 50 ml of round bottomed kjeldahl flask , 2 g of K_2SO_4 –HgO mixture was added to it , 3ml of conc. H_2SO_4 was added ,

heated the flask on a digestion rack till a pale green colour comes . It was then allowed to cool and diluted with 50 ml of water and filtered the digest . Distillation method was followed and then titrated against 20 % H_2SO_4 . Blank digest was prepared with reagents only.

Calculation :-

T= ml/140Hcl used for titration

$$N(\%) = \frac{T\,(ml) \times \text{Solution volume}\,(ml)}{10^2 \times \text{aliquot}\,(ml) \times \text{sample wt}\,(g)}$$

Analysis of plant P and K (Allen, 1974) : -

Procedure :- 1g of plant material was taken and 5 ml of triacid (HNO_3 + perchloric acid + H_2SO_4 in the ratio (10:4:1) was added , filtered and made the volume in to 50 ml by dist H_2O. 10 ml of aliquot with 10 ml of ammonium venamolybdate was added and made the volume . The O.D was read in a spectrophotometer at 490 nm and for K the reading was taken in flame photometer and compared with blank.

Fig- 12:- Nutrient uptake (N,P and K) of valley practice soil in field conditions in pure cropping system.

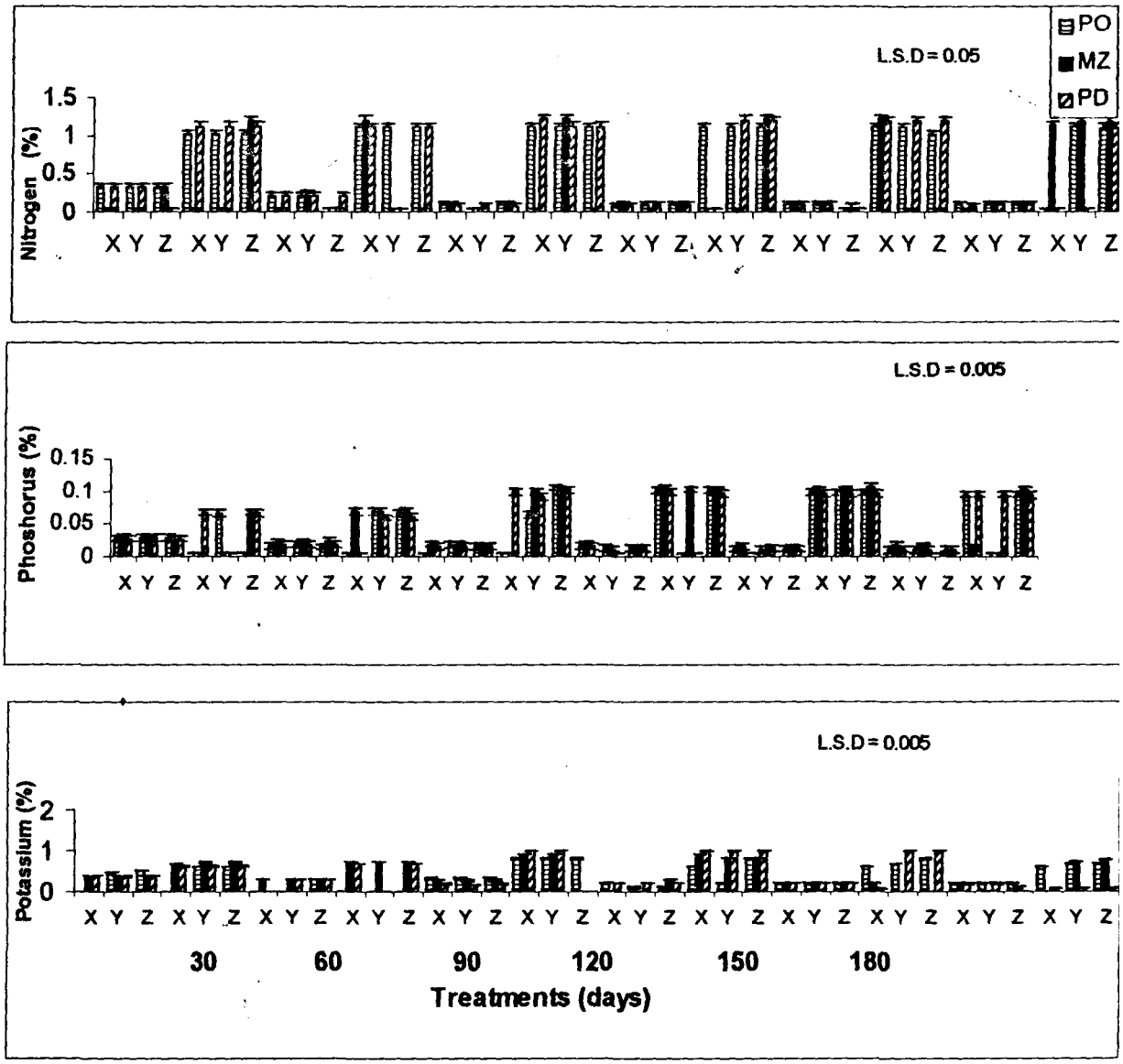


Fig- 13:- Nutrient uptake (N,P and K) of terrace practice soil in field conditions in pure cropping system.

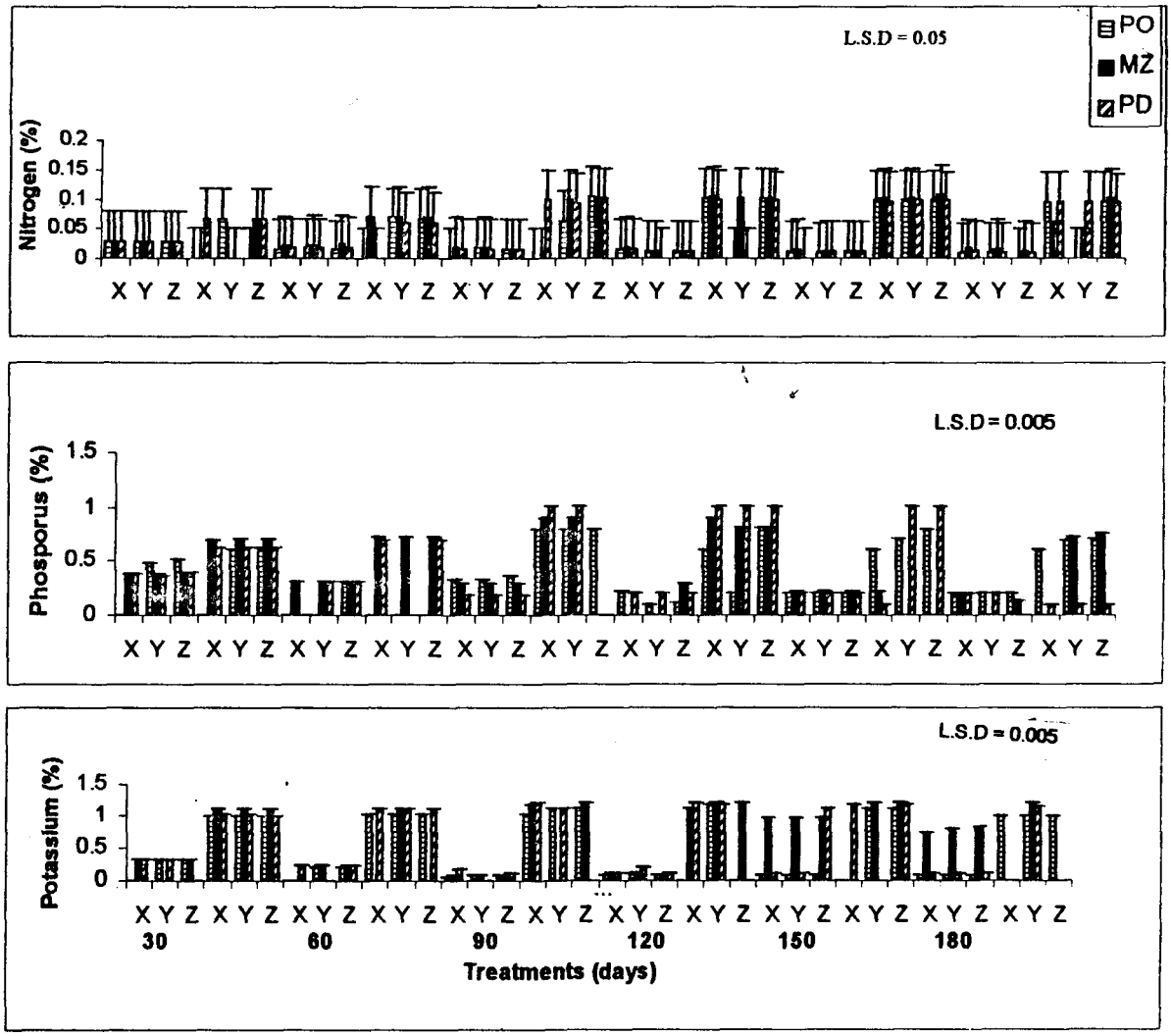


Fig- 14:- Nutrient uptake (N,P and K) of jhum practice soil in field conditions in pure cropping system.

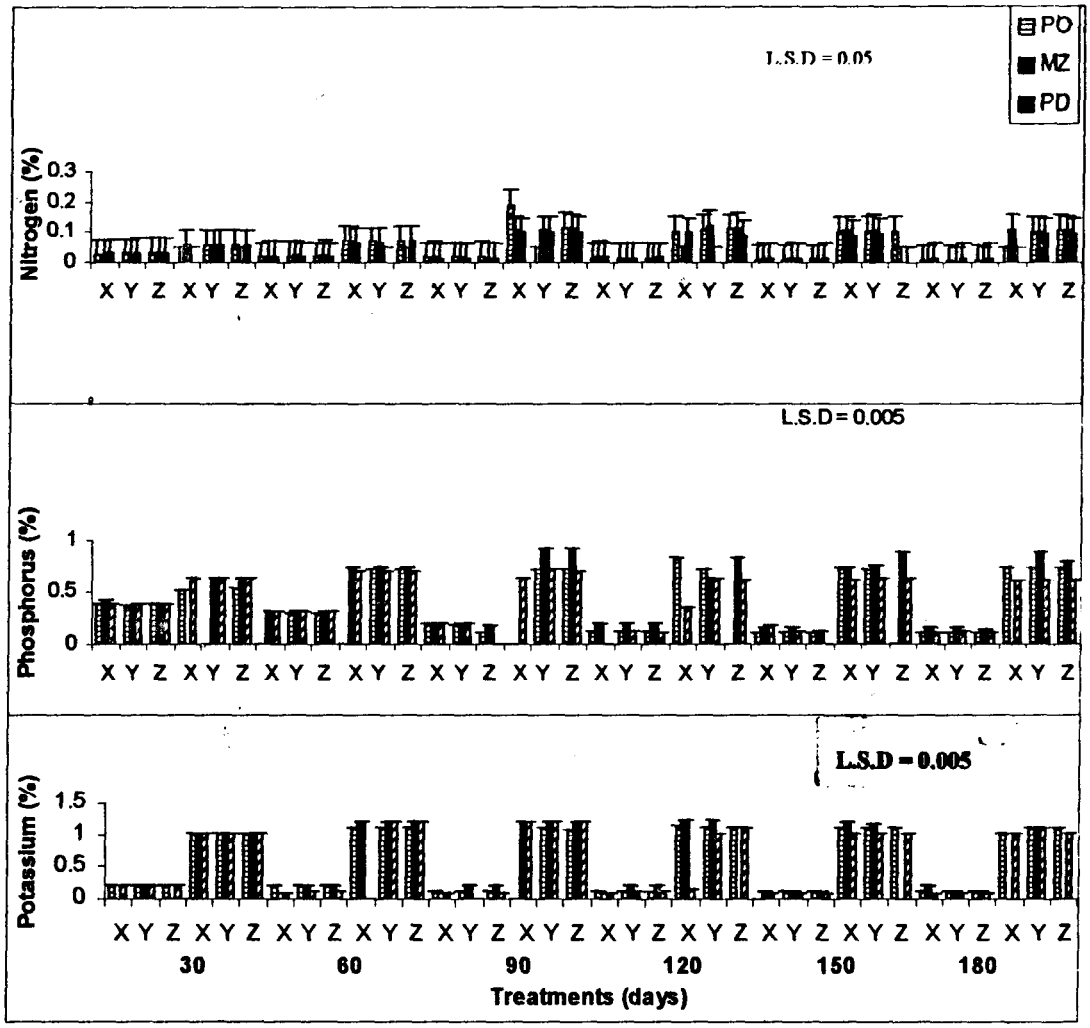


Fig- 15:- Nutrient uptake (N,P and K) of valley practice soil in field conditions in mixed cropping system

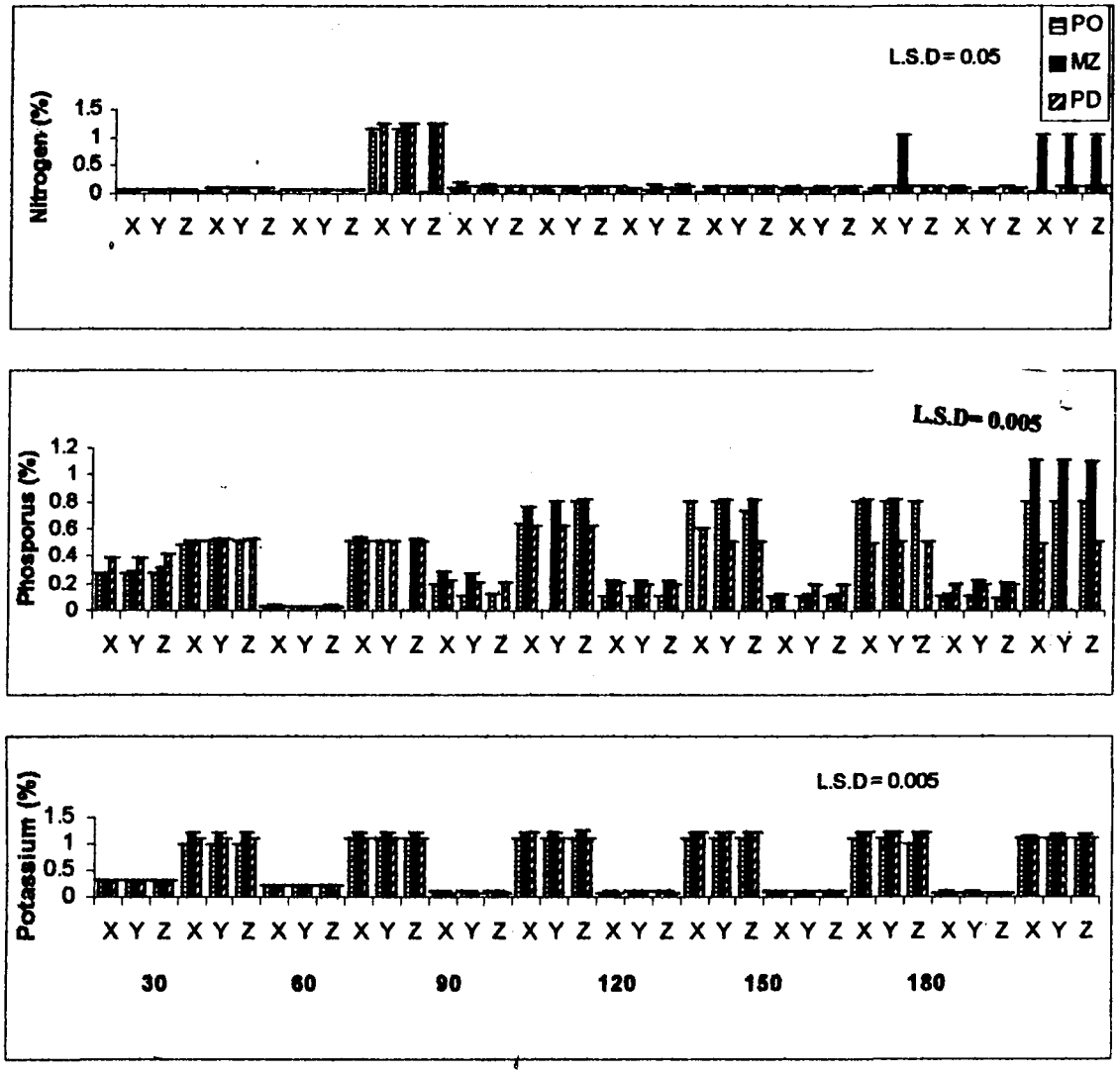


Fig- 16:- Nutrient uptake (N,P and K) of terrace practice soil in field conditions in mixed cropping system

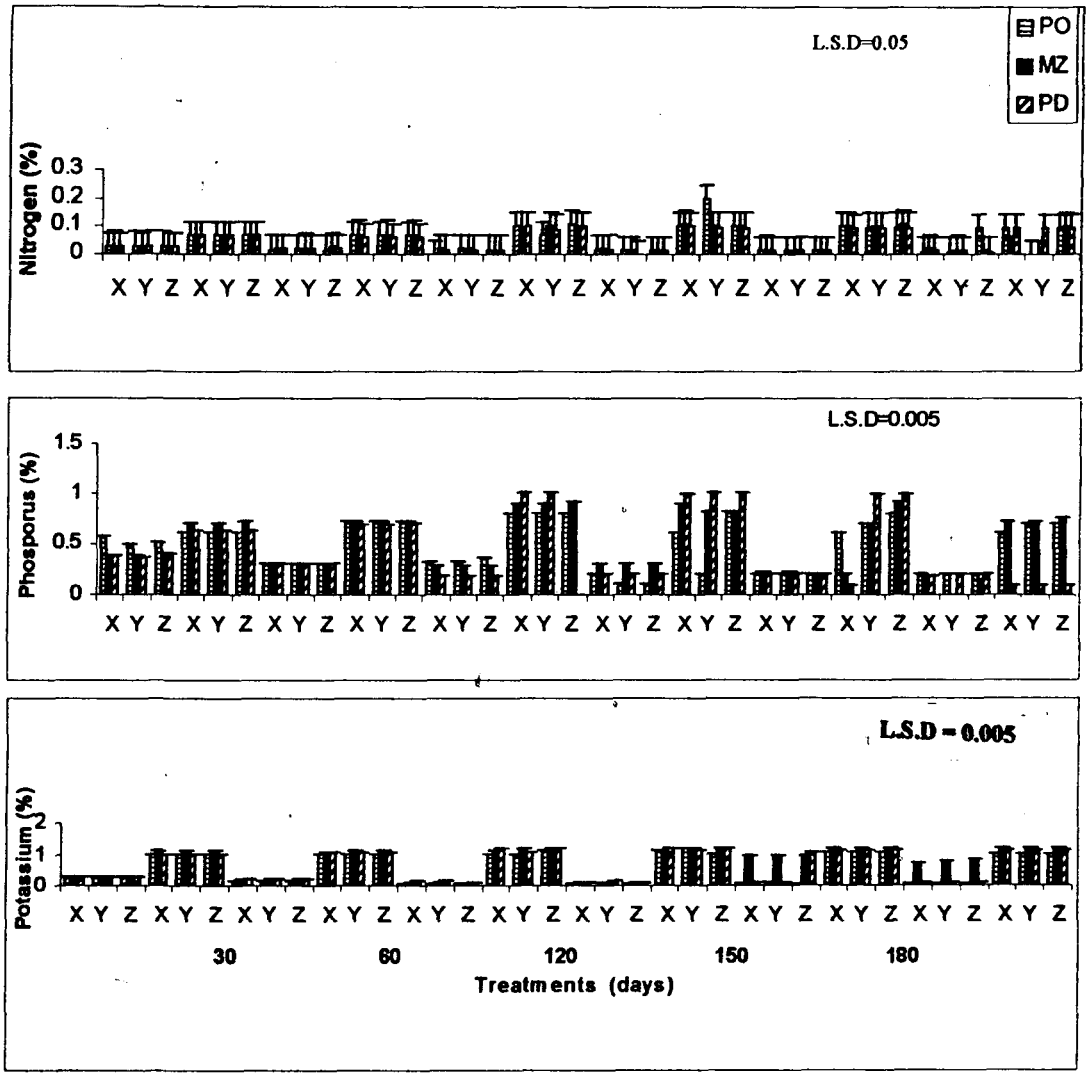


Fig- 17:- Nutrient uptake (N,P and K) of jhum practice soil in field conditions in mixed cropping system

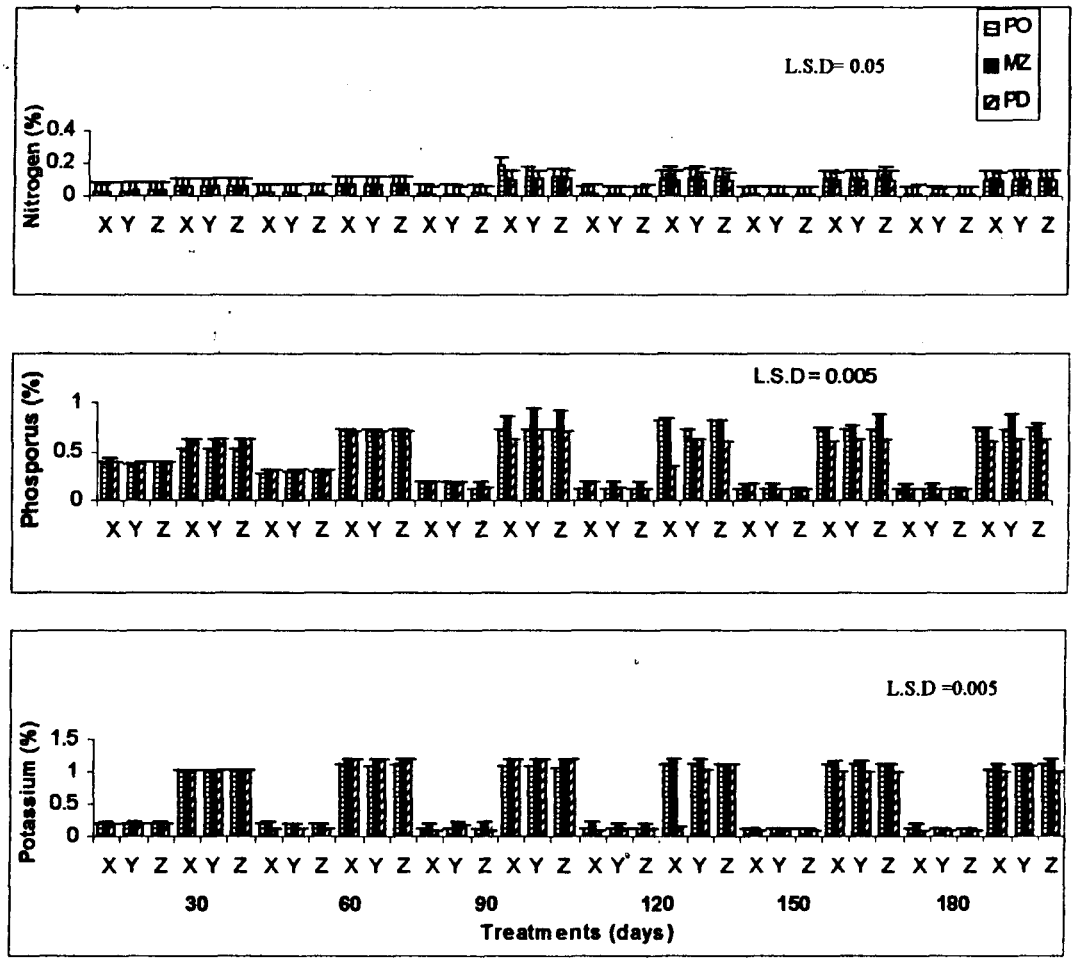


Table- 10 :- Correlation coefficient (r) values among various transfer levels of nitrogen in valley practice from 30 to 180 days in maize , paddy and potato crops in pure cropping system.

MZ

	30(N%)	60(N%)	90(N%)	120(N%)	150(N%)	180(N%)
30(N%)	*1					
60(N%)	-1	*1				
90(N%)	*1	-1	*1			
120(N%)	0.500	-0.500	0.500	*1		
150(N%)	-0.866	0.866	-0.866	-0.000	*1	
180(N%)	0.5	-0.5	0.5	*1	0	1*
		PD				
	30(N%)	60(N%)	90(N%)	120(N%)	150(N%)	180(N%)
30(N%)	*1					
60(N%)	0.944	*1				
90(N%)	0.977	0.992	*1			
120(N%)	0.501	0.756	0.673	*1		
150(N%)	*1	0.944	0.977	0.501	*1	
180(N%)	*1	0.944	0.977	0.501	*1	*1
		PO				
	30(N%)	60(N%)	90(N%)	120(N%)	150(N%)	180(N%)
30(N%)	*1					
60(N%)	0.5	*1				
90(N%)	0.755	0.944	*1			
120(N%)	*1	0.5	0.755	*1		
150(N%)	*1	0.5	0.755	*1	*1	
180(N%)	0.866	0.866	0.981	0.866	0.866	*1

* , ** :- Significant at 1 % and 5 % respectively.

Table- 11 :- Correlation coefficient (r) values among various transfer levels of phosphorus in valley practice from 30 to 180 days in maize , paddy and potato crops in pure cropping system.

		MZ				
	30(P%)	60(P%)	90(P%)	120(P%)	150(P%)	180(P%)
30(P%)	*1					
60(P%)	*1	*1				
90(P%)	*1	*1	*1			
120(P%)	*1	*1	*1	*1		
150(P%)	0.5	0.5	0.5	0.5	*1	
180(P%)	0.994	0.994	0.994	0.994	0.585	*1
		PD				
	30(P%)	60(P%)	90(P%)	120(P%)	150(P%)	180(P%)
30(P%)	*1					
60(P%)	*1	*1				
90(P%)	*1	*1	*1			
120(P%)	0.999	0.999	0.999	*1		
150(P%)	*1	*1	*1	0.999	*1	
180(P%)	0.579	0.579	0.579	0.592	0.579	*1
		PO				
	30(P%)	60(P%)	90(P%)	120(P%)	150(P%)	180(P%)
30(P%)	*1					
60(P%)	0.993	*1				
90(P%)	0.944	0.976	*1			
120(P%)	0.981	0.953	0.866	*1		
150(P%)	*1	0.993	0.944	0.981	*1	
180(P%)	-0.397	-0.289	-0.075	-0.563	-0.397	*1

*** , ** : - Significant at 1 % and 5 % respectively .**

Table- 12 :- Correlation coefficient (r) values among various transfer levels of potassium in valley practice from 30 to 180 days in maize , paddy and potato crops in pure cropping system.

		MZ				
	30(K%)	60(K%)	90(K%)	120(K%)	150(K%)	180(K%)
30(K%)	*1					
60(K%)		*1				
90(K%)	0.866	0.998	*1			
120(K%)	*1	**0.997	0.866	*1		
150(K%)	0.944	0.984	0.981	0.944	*1	
180(K%)	0.999	0.983	0.873	0.999	0.949	*1
		PD				
	30(K%)	60(K%)	90(K%)	120(K%)	150(K%)	180(K%)
30(K%)	*1					
60(K%)	0.917	*1				
90(K%)	0.917	*1	*1			
120(K%)	0.866	0.993	0.993	*1		
150(K%)	0 0.866	0.993	0.993	*1	*1	
180(K%)	0.992	0.959	0.959	0.920	0.920	*1
		PO				
	30(K%)	60(K%)	90(K%)	120(K%)	150(K%)	180(K%)
30(K%)	*1					
60(K%)	0	*1				
90(K%)	0.866	-0.5	*1			
120(K%)	*1	0.866	0.866	*1		
150(K%)	0.866	-0.5	*1	0.866	*1	
180(K%)	0.866	-0.5	*1	0.866	*1	*1

*, ** :- Significant at 1 % and 5 % respectively.

Table- 13 :- Correlation coefficient (r) values among various transfer levels of nitrogen in valley practice from 30 to 180 days in maize , paddy and potato crops in mixed cropping system.

		MZ				
	30(N%)	60(N%)	90(N%)	120(N%)	150(N%)	180(N%)
30(N%)	*1					
60(N%)	0.5	*1				
90(N%)	0.755	-0.188	*1			
120(N%)	-0.956	-0.225	-0.914	*1		
150(N%)	**0.998	0.866	-0.654	0.292	*1	
180(N%)	0.188	-0.755	0.785	-0.467	-0.981	*1
			PD			
	30(N%)	60(N%)	90(N%)	120(N%)	150(N%)	180(N%)
30(N%)	*1					
60(N%)	-1	*1				
90(N%)	**0.993	-0.993	*1			
120(N%)	-0.5	0.5	-0.592	*1		
150(N%)	0.802	-0.802	0.732	0.114	*1	
180(N%)	0.514	-0.514	0.417	0.485	0.924	*1
		PO				
	30(N%)	60(N%)	90(N%)	120(N%)	150(N%)	180(N%)
30(N%)	*1					
60(N%)	0.866	*1				
90(N%)	-0.009	0.492	*1			
120(N%)	-0.866	-1	-0.492	*1		
150(N%)	0.998	0.998	0.789	0.996	*1	
180(N%)	-0.327	0.188	0.947	-0.188	0.778	*1

*** , ** : -Significant at 1 % and 5 % respectively.**

Table- 14 :- Correlation coefficient (r) values among various transfer levels of phosphorus in valley practice from 30 to 180 days in maize , paddy and potato crops in mixed cropping system.

		MZ				
	30(P%)	60(P%)	90(P%)	120(P%)	150(P%)	180(P%)
30(P%)	*1					
60(P%)	-0.654	*1				
90(P%)	0.775	-0.985	*1			
120(P%)	0.866	-0.944	0.987	*1		
150(P%)	0	0.755	-0.631	-0.5	*1	
180(P%)	0.866	-0.188	0.355	0.5	0.5	*1
		PD				
	30(P%)	60(P%)	90(P%)	120(P%)	150(P%)	180(P%)
30(P%)	*1					
60(P%)	0.998	*1				
90(P%)	0.999	0.944	*1			
120(P%)	0.976	-0.693	-0.891	*1		
150(P%)	0.989	-0.5	-0.755	0.970	*1	
180(P%)		-0.5	-0.755	0.970	1	1
	0.765	PO				
	30(P%)	60(P%)	90(P%)	120(P%)	150(P%)	180(P%)
30(P%)	*1					
60(P%)	0.944	*1				
90(P%)	0.944	0.785	*1			
120(P%)	-1	-0.944	-0.944	*1		
150(P%)	0.720	0.907	0.453	-0.720	*1	
180(P%)	0.277	-0.052	0.576	-0.277	-0.466	*1

*** ,* * :- Significant at 1 % and 5 % respectively.**

Table- 15 :- Correlation coefficient (r) values among various transfer levels of potassium in valley practice from 30 to 180 days in maize , paddy and potato crops in mixed cropping system.

		MZ				
	30(K%)	60(K%)	90(K%)	120(K%)	150(K%)	180(K%)
30(K%)	*1					
60(K%)	-0.459	*1				
90(K%)	-0.979	0.628	*1			
120(K%)	-0.996	0.529	0.992	*1		
150(K%)	0.882	0.011	-0.770	-0.842	*1	
180(K%)	0.999	-0.485	-0.985	-0.998	0.868	*1
		PD				
	30(K%)	60(K%)	90(K%)	120(K%)	150(K%)	180(K%)
30(K%)	*1					
60(K%)	0.912	*1				
90(K%)	0.585	0.0866	*1			
120(K%)	-0.288	0.129	0.607	*1		
150(K%)	-0.594	-0.870	-0.999	-0.600	0.998	*1
180(K%)	0.994	0.866	0.5	-0.383	-0.507	1
		PO				
	30(K%)	60(K%)	90(K%)	120(K%)	150(K%)	180(K%)
30(K%)	*1					
60(K%)	0,.969	*1				
90(K%)	0.096	0.336	*1			
120(K%)	0.119	0.358	0.999	*1		
150(K%)	0.861	0.711	-0.421	-0.400	*1	
180(K%)	-0.114	-0.353	-0.999	-0.999	0.405	*1

*** , ** : - Significant at 1 % and 5 % respectively.**

Table- 16 :- Correlation coefficient (r) values among various transfer levels of nitrogen in terrac practice from 30 to 180 days in maize , paddy and potato crops in pure cropping system.

	30(N%)	60(N%)	90(N%)	120(N%)	150(N%)	180(N%)
30(N%)	*1					
60(N%)	*1	*1				
90(N%)	0.5	0.565	*1			
120(N%)	0.866	0.866	0.866	*1		
150(N%)	0.5	0.5	*1	0.866	*1	
180(N%)	*1	*1	0.512	0.866	0.5	*1
		PD				
	30(N%)	60(N%)	90(N%)	120(N%)	150(N%)	180(N%)
30(N%)	1					
60(N%)	0.807	*1				
90(N%)	0.904	0.981	*1			
120(N%)	0.904	0.981	*1	*1		
150(N%)	0.947	0.953	0.993	0.993	0.998	*1
180(N%)	0.704	0.987	0.940	0.940	0.894	*1
		PO				
	30(N%)	60(N%)	90(N%)	120(N%)	150(N%)	180(N%)
30(N%)	*1					
60(N%)	0.339	*1				
90(N%)	0.339	*1	*1			
120(N%)	0.155	0.981	0.981	*1		
150(N%)	-0.033	0.928	0.928	0.981	*1	
180(N%)	0.492	0.985	0.985	0.936	0.853	*1

*** , ** :- Significant at 1 % and 5 % respectively**

Table- 17 :- Correlation coefficient (r) values among various transfer levels of phosphorus in terrace practice from 30 to 180 days in maize , paddy and potato crops in pure cropping system.

		MZ				
	30(P%)	60(P%)	90(P%)	120(P%)	150(P%)	180(P%)
30(P%)	*1					
60(P%)	0	*1				
90(P%)	-0.5	0.866	*1			
120(P%)	0.5	0.866	0.5	*1		
150(P%)	0.981	0.928	0.944	0.942	*1	
180(P%)	0.866	0.755	*1	0.944	0.944	*1
		PD				
	30(P%)	60(P%)	90(P%)	120(P%)	150(P%)	180(P%)
30(P%)	*1					
60(P%)	0.981	*1				
90(P%)	0.866	0.755	*1			
120(P%)	0.981	0.928	0.944	*1		
150(P%)	0.981	0.928	0.944	*1	*1	
180(P%)	0.866	0.755	*1	0.944	0.944	*1
		PO				
	30(P%)	60(P%)	90(P%)	120(P%)	150(P%)	180(P%)
30(P%)	*1					
60(P%)	0.866	*1				
90(P%)	0.866	*1	*1			
120(P%)	*1	0.866	0.866	*1		
150(P%)	0.999	0.887	0.887	0.999	*1	
180(P%)	0.874	0.999	0.999	0.874	0.895	*1

*** , ** : - Significant at 1 % and 5 % respectively.**

Table- 18 :-Correlation coefficient (r) values among various transfer levels of potassium in terrace practice from 30 to 180 days in maize , paddy and potato crops in pure cropping system.

		MZ				
	30(K%)	60(K%)	90(K%)	120(K%	150(K%)	180(K%)
30(K%)	*1					
60(K%)	0.640	*1				
90(k%)	0.938	0.866	*1			
120(K%)	0.938	0.866	*1	*1		
150(K%)	0.938	0.866	*1	*1	*1	
180(K%)	-0.999	-0.654	-0.944	-0.944	-0.944	*1
		PD				
	30(K%)	60(K%)	90(K%)	120(K%)	150(K%)	180(K%)
30(K%)	*1					
60(K%)	0.998	*1				
90(k%)	0.876	*1	*1			
120(K%)	0.976	*1	*1	*1		
150(K%)	0.765	**0.997	**0.997	**0.997	*1	
180(K%)	0.874	0.999	0.999	0.999	0.999	*1
		PO				
	30(K%)	60(K%)	90(K%)	120(K%)	150(K%)	180(K%)
30(K%)	*1					
60(K%)	0.928	*1				
90(k%)	0.891	0.995	*1			
120(K%)	0.995	0.891	0.846	*1		
150(K%)	0.989	0.866	0.817	0.998	*1	
180(K%)	-0.818	-0.973	-0.990	-0.762	-0.727	*1

*** , ** :- Significant at 1 % and 5 % respectively.**

Table- 19:-Correlation coefficient (r) values among various transfer levels of nitrogen in terrace practice from 30 to 180 days in maize , paddy and potato crops in mixed cropping system.

		MZ				
	30(N%)	60(N%)	90(N%)	120(N%)	150(N%)	180(N%)
30(N%)	*1					
60(N%)	0.098	*1				
90(N%)	-0.990	0.135	*1			
120(N%)	0.925	-0.379	-0.968	*1		
150(N%)	-0.970	-0.240	0.929	-0.807	*1	
180(N%)	-0.188	-0.981	0.054	0.197	0.419	*1
		PD				
	30(N%)	60(N%)	90(N%)	120(N%)	150(N%)	180(N%)
30(N%)	*1					
60(N%)	-0.576	*1				
90(N%)	0.838	-0928	*1			
120(N%)	0.942	\0.817	0.972	*1		
150(N%)	0.204	-0.917	0.704	0.520	*1	
180(N%)	-0.242	0.932	-0.731	-0.553	-0.999	*1
		PO				
	30(N%)	60(N%)	90(N%)	120(N%)	150(N%)	180(N%)
30(N%)	*1					
60(N%)	0.866	1*				
90(N%)	-0.476	0.026	*1			
120(N%)	-0.792	-0.381	0.913	*1		
150(N%)	-0693	-0.240	0.963	0.988	*1	
180(N%)	0209	0.670	0.759	0.430	0.559	*1

***, **: - Significant at 1 % and 5 % respectively.**

Table- 20:-Correlation coefficient (r) values among various transfer levels of phosphorus in terrace practice from 30 to 180 days in maize , paddy and potato crops in mixed cropping system.

		MZ				
	30(P%)	60(P%)	90(P%)	120(P%)	150(P%)	180(P%)
30(P%)	*1					
60(P%)	0.866	*1				
90(P%)	0.800	0.393	*1			
120P%)	-0.810	-0.409	-0.999	*1		
150(P%)	-0.5	**0.997	-0.919	0.912	*1	
180(P%)	-0.211	0.305	-0.755	0.743	0.952	*1
		PD				
	30(P%)	60(P%)	90(P%)	120(P%)	150(P%)	180(P%)
30(P%)	*1					
60(P%)	-0.866	*1				
90(P%)	-0.5	0.866	*1			
120P%)	0.381	-0.792	-0.991	*1		
150(P%)	-0.409	0.810	-0.994	-0.999	*1	
180(P%)	-0.866	0.5	0	0.132	-0.101	*1
		PO				
	30(P%)	60(P%)	90(P%)	120(P%)	150(P%)	180(P%)
30(P%)	*1					
60(P%)	**0.995	*1				
90(P%)	0.944	0.911	*1			
120P%)	-0.720	-0.658	-0.907	*1		
150(P%)	0.991	0.975	0.979	-0.805	*1	
180(P%)	*1	0.995	0.944	-0.720	0.991	*1

*** , ** : - Significant at 1 % and 5 % respectively.**

Table- 21:-Correlation coefficient (r) values among various transfer levels of potassium in terrace practice from 30 to 180 days in maize , paddy and potato crops in mixed cropping system.

		MZ				
	30(K%)	60(K%)	90(K%)	120(K%)	150(K%)	180(K%)
30(K%)	*1					
60(K%)	-0.438	*1				
90(K%)	0.888	-0.802	*1			
120(K%)	0.773	0.230	0.395	*1		
150(K%)	0.183	0.802	-0.289	0.764	*1	
180(K%)	0.069	0.866	-0.397	0.686	*0.993	*1
		PD				
	30(K%)	60(K%)	90(K%)	120(K%)	150(K%)	180(K%)
30(K%)	*1					
60(K%)	*0.998	*1				
90(K%)	0.763	*0.995	*1			
120(K%)	0.112	**0.997	-0.555	*1		
150(K%)	0.981	0.567	0.624	0.302	*1	
180(K%)	0.076	0.889	0.701	-0.982	-0.118	*1
		PO				
	30(K%)	60(K%)	90(K%)	120(K%)	150(K%)	180(K%)
30(K%)	*1					
60(K%)	0.576	*1				
90(K%)	0.860	0.080	*1			
120(K%)	0.896	0.154	**0.997	*1		
150(K%)	0.529	-0.388	0.887	0.850	*1	
180(K%)	0.944	0.277	0.979	*0.992	0.777	*1

***, ** : - Significant at 1 % and 5 % respectively.**

Table-22 :- Correlation coefficient values among various transfer levels of nitrogen in jhum practice from 30 to 180 days in maize, paddy and potato crops in pure cropping system

		MZ				
	30(N%)	60(N%)	90(N%)	120(N%)	150(N%)	180(N%)
30(N%)	*1					
60(N%)	0.866	*1				
90(N%)	0.866	*1	*1			
120(N%)	0.866	*1	*1	*1		
150(N%)	0.866	*1	*1	*1	*1	
180(N%)	0.976	0.998	0.999	0 .456	0.675	*1
		PD				
	30(N%)	60(N%)	90(N%)	120(N%)	150(N%)	180(N%)
30(N%)	*1					
60(N%)	0.928	*1				
90(N%)	0.928	*1	*1			
120(N%)	0.981	0.981	0.981	*1		
150(N%)	0.944	0.755	0.755	0.866	*1	
180(N%)	0.891	0.995	0.995	0.960	0.693	*1
	30(N%)	60(N%)	90(N%)	120(N%)	150(N%)	180(N%)
		PO				
30(N%)	*1					
60(N%)	0.981	*1				
90(N%)	*1	0.981	*1			
120(N%)	0.981	*1	0.998	*1		
150(N%)	0.998	0.990	0.998	0.990	*1	
180(N%)	*0.976*	*0.917*	*0.976*	*0.917*	*0.963*	*1

*, ** : Significant at 1 % and 5 % respectively

Table-23 :- Correlation coefficient values among vrious transfer levels of phosphorusin jhum practice from 30 to 180 days in maize, pady and potato crops in pure croppng system.

		MZ				
	30(P%)	60(P%)	90(P%)	120(P%)	150(P%)	180(P%)
30(P%)	*1					
60(P%)	0.578	*1				
90(P%)	*1	0.509	*1			
120(P%)	*1	0.578	*1	1*		
150(P%)	-0.534	0.532	-0.534	-0.523	*1	
180(P%)	-0.534	0.512	-0.578	-0.509	*1	*1
		PD				
	30(P%)	60(P%)	90(P%)	120(P%)	150(P%)	180(P%)
30(P%)	*1					
60(P%)	0.755	*1				
90(P%)	0.866	0.981	*1			
120(P%)	0.866	0.981	*1	*1		
150(P%)	0.500	0.945	0.866	0.866	*1	
180(P%)	0.896	0.967	**0.997	**0.997	0.832	*1
		PO				
		30(P%)	60(P%)	90(P%)	120(P%)	150(P%)
30(P%)	*1					
60(P%)	0.928	*1				
90(P%)	*1	0.928	*1			
120(P%)	0.981	0.981	0.981	*1		
150(P%)	0.756	0.945	0.756	0.866	*1	
180(P%)	0.984	0.848	0.984	0.933	0.629	*1

*** , ** : - Significant at 1 % and 5 % respectively**

Table-24 :- Correlation coefficient values among various transfer levels of potassium in jhum practice from 30 to 180 days in maize, paddy and potato crops in pure cropping system.

		MZ				
	30(K%)	*60(K%)*	*90(K%)*	*120(K%)*	*150(K%)*	*180(L%)*
30(K	*1					
60(K%)	0.988	*1				
90(K%)	0.999	0.665	*1			
120(K%)	0.987	0.876	0.567	*1		
150(K%)	0.519	0.456	0.5	**0.997	*1	
180(K%)	0.951	0.456	0.944	0.765	0.755	*1
		PD				
	30(K%)	*60(K%)*	*90(K%)*	*120(K%)*	*150(K%)*	*180(L%)*
30(K	*1					
60(K%)	*1	*1				
90(K%)	*1	*1	*1			
120(K%)	0.928	0.928	0.928	*1		
150(K%)	0.951	0.951	0.951	**0.997	*1	
180(K%)	0.951	0.951	0.951	**0.997	0.999	*1
		PO				
	30(K%)	*60(K%)*	*90(K%)*	*120(K%)*	*150(K%)*	*180(L%)*
30(K	*1					
60(K%)	**0.997	*1				
90(K%)	-0.889	-0.921	*1			
120(K%)	0.993	0.981	-0.830	*1		
150(K%)	0.917	0.944	-0.997	0.866	1*	
180(K%)	0.983	0.966	-0.790	**0.997	0.829	*1

*** , ** : - Significant at 1 % and 5 % respectively.**

Table-25 :- Correlation coefficient (r) values among various transfer levels of nitrogen in jhum practice from 30 to 180 days in maize, paddy and potato crops in mixed cropping system.

		MZ				
	30(N%)	*60(N%)*	*90(N%)*	*120(N%)*	*150(N%)*	*180(N%)*
30(N%)	*1					
60(N%)	0.944	*1				
90(N%)	-0.589	-0.755	*1			
120(N%)	-0.904	-0.994	0.821	*1		
150(N%)	0.344	0.018	0.640	0.089	*1	
180(N%)	0.585	0.287	0.409	-0.182	0.962	*1
		PD				
	30(N%)	*60(N%)*	*90(N%)*	*120(N%)*	*150(N%)*	*180(N%)*
30(N%)	*1					
60(N%)	0.981	*1				
90(N%)	0.755	0.866	*1			
120(N%)	0.981	*1	0.866	*1		
150(N%)	-0.940	-0.987	-0.933	-0.987	*1	
180(N%)	0.999	0.986	0.773	0.986	-0.949	*1
		PO				
	30(N%)	*60(N%)*	*90(N%)*	*120(N%)*	*150(N%)*	*180(N%)*
30(N%)	*1					
60(N%)	0.987	*1				
90(N%)	-0.359	-0.509	*1			
120(N%)	-0.996	-0.994	0.432	*1		
150(N%)	-0.984	-0.944	0.188	0.967	*1	
180(N%)	-0.999	-0.981	0.327	0.993	0.989	*1

*** , ** : - Significant at 1 % and 5 % respectively.**

Table-26 :- Correlation coefficient (r) values among various transfer levels of phosphorus in jhum practice from 30 to 180 days in maize, paddy and potato crops in mixed cropping system.

		MZ				
	30(P%)	*60(P%)*	*90(P%)*	*120(P%)*	*150(P%)*	*180(P%)*
30(P%)	*1					
60(P%)	0.5	*1				
90(P%)	-0.912	-0.101	*1			
120(P%)	-0.802	-0.917	0.488	*1		
150(P%)	-0.832	-0.896	0.532	-0.998	*1	
180(P%)	-0.578	0.509	0.810	-0.114	-0.064	*1
		PD				
	30(P%)	30(P%)	30(P%)	30(P%)	30(P%)	30(P%)
30(P%)	*1					
60(P%)	.976	*1				
90(P%)	.987	*1	*1			
120(P%)	0.523	0.866	0.866	*1		
150(P%)	0.999	0.007	0.007	0.506	*1	
180(P%)	0.359	-0.933	-0.933	-0.628	0.352	*1
		PO				
	30(P%)	30(P%)	30(P%)	30(P%)	30(P%)	30(P%)
30(P%)	*1					
60(P%)	0.917	*1				
90(P%)	0.731	0.400	*1			
120(P%)	-0.944	-0.997	-0.467	*1		
150(P%)	-0.944	-0.997	-0.467	*1	*1	
180(P%)	0.578	0.114	0.956	-0.188	-0.188	*1

*** , ** : - Significant at 1 % and 5 % respectively**

Table-27 :- Correlation co-efficient (r) values among various transfer levels of potassium in jhum practce from 30 to 180 days in maize, paddy and potato crops in mixed cropping system

		MZ				
	30(K%)	*60(K%)*	*90(K%)*	*120(K%)*	*150(K%)*	*180(K%)*
30(K%)	*1					
60(K%)	0.907	*1				
90(K%)	0.933	0.696	*1			
120(K%)	-0.737	-0.952	-0.445	*1		
150(K%)	-0.240	0.188	-0.573	-0.478	*1	
180(K%)	-0.240	0.188	-0.573	-0.478	*1	*1
		PD				
	30(K%)	*60(K%)*	*90(K%)*	*120(K%)*	*150(K%)*	*180(K%)*
30(K%)	*1					
60(K%)	0.970	*1				
90(K%)	0.188	-0.419	*1			
120(K%)	0.487	-0.683	0.949	*1		
150(K%)	-0.188	-0.052	0.928	0.764	*1	
180(K%)	0.904	-0.775	-0.248	0.068	-0.590	*1
		PO				
	30(K%)	*60(K%)*	*90(K%)*	*120(K%)*	*150(K%)*	*180(K%)*
30(K%)	*1					
60(K%)	0.563	*1				
90(K%)	-0.433	0.578	*1			
120(K%)	0.953	0.287	-0.685	*1		
150(K%)	0.998	0.609	-0.381	0.934	*1	
180(K%)	0.978	0.720	-0.240	0.871	**0.988	*1

*** , ** : - Significant at 1 % and 5 % respectively**

Results

It was observed that the transfer of Nitrogen (%), Phosphorus (%) , and Potassium (%) in valley practice was highest in double number of spore inoculated treatments , moderate in half number of spore inoculated treatments and least in control treatments followed by moderate uptake of nutrients i.e (N, P, and K) in terrace practice , whereas in jhum practice least nutrient transfer rate was observed.(Figs- 12, 13, and 14) .

The transfer of N(%) was found to be the highest in potato(1.210 ±0.015), moderate in maize (1.121±0.085) and least in paddy (1.118±0.065) crops of valley practice in 30 days treatments. Whereas in 180 days treatment the transfer level was different in two different crops i.e highest in maize (1.287±0.025) , than in paddy (1.238±0.055). There was not much difference in the rate of transfer of N(%) during the period between 60-150 days as compared to 180 days , whereas in terrace practice the rate of transfer of N(%) in three different treatments was highest in potato (1.201±0.025-1.206±0.025) , moderate in maize (1.124±0.054-1.206±0.054) and least in paddy (1.108±0.105-1.204±0.015) . In case of jhum practice the rate of transfer of N(%) was highest in maize (1.304±0.015) , moderate in paddy (1.297±0.015) and least in potato (1.012±0.05) (Fig-12).It was seen that the transfer of P(%) was highest in valley practice during the period 120-180 days than other experimental periods i.e 30-150 days . The highest P(%) transfer rate was observed in maize (0.140±0.005), moderate in paddy (0.132±0.005) and least in potato (0.128±0.005) crops followed by moderate rate in terrace practice and highest rate was found in maize (0.132±0.005) , as compared to paddy (0.128±0.015) and potato crop (0.102±0.075) and least in jhum practice .The uptake rate of K(%) was found to be moderate in 90 days in three

different crops than other periods i.e (0.501±0.005-1.001±0.005) and it started increasing from 150-180 days in two different crops Maize and paddy i.e (0.912±0.005-1.002±0.005) in valley practice followed by moderate rate in terrace and least in jhum practices .(Fig-13), whereas the transfer rate (%) in 180 days was highest in maize (0.989±0.005) , than in paddy (0.817±0.005)(Fig-13). The overall result showed that the nutrient uptake (N,P and K) was highest in valley practice , moderate in terrace and least in jhum and the level of transfer(%) was highest in double number of inoculated treatments , moderate in half number of inoculated treatments , and least in control treatments in three different agricultural practices and crops . (Figs-12,13,and14).It was observed that in three different cropping systems the nutrient (N,P and K) transfer (%) was highest in double number of spore inoculated treatments , moderate in half number of spore inoculated treatments and least in control treatments.In the mixed cropping systems (potato, maize, and paddy grown together) , it was found that starting from 150-180 days only in maize crops the nutrient transfer i.e (N,P and K) was highest than other periods. In valley practice , the transfer of N(%) in both maize and paddy crops were higher than potato i.e maize (1.238±0.105) , paddy (1.206±0.205) , paddy (1.206±0.035) (Fig-15) , whereas in mixed cropping system of terrace practice the N(%) transfer was moderate than valley practice i.e maize (1.121±0.205-1.208±0.205) during the study period and in jhum practice it was seen that N(%) transfer was least than valley and terrace practices during the study periods., whereas P(%) uptake was least in valley practice i.e maize (0.130±0.005), paddy (0.121±0.005) and potato (0.101±0.065) (Fig-16) and moderate in terrace practice , and highest in jhum practice i.e maize (1.230±0.105) , paddy (0.906±0.008) and potato (0.801±0.023) (Fig-17). It was seen that K(%) transfer was highest in jhum practice than valley and terrace practices i.e maize (1.230±0.005) , paddy (1.228±0.005) and potato (1.001±0.005) . The overall study showed that the nutrient uptake

(N,P and K) was always highest in double number of spore inoculated treatments , moderate in half number of spore inoculated treatment and least in control treatments(Figs-15,16, and 17).

It was also observed from the comparative study of both pure and mixed cropping systems that the uptake of nutrients i.e (N,P and K) were more in pure cropping systems than mixed cropping systems in all the three different agricultural practices. Double number(Z) of spore inoculated treatments showed the highest transfer , moderate in half number(Y) of spore inoculated treatments and least in control (X) treatments.

It was observed that the transfer of N (%) in valley practice was highest i.e (1.011±0.015) in potato, (1.210±0.065), in maize and (1.121±0.105) in paddy crops in 30 days followed by uniform level of transfer till 180 days i.e (1.128±0.015) % in potato , (1.287±0.075) % in maize and (1.238±0.065) % in paddy crops. Whereas the transfer of P (%) in valley practice was highest starting from 120 days till 180 days in three different crops , highest P (%) transfer in maize plants i.e (0.140±0.005) % in double number of spore(Z) inoculated conditions, whereas less transfer (%) in half number(Y) spore inoculated treatments as compared to control treatment(X). The transfer of K (%) was found to be more in 90 days in all the three crops i.e 0.501±0.065-1.001±0.065) % and it started declining in 180 days i.e (0.912±0.025 %) (Fig-12) , Whereas in terrace practice the N (%) uptake was less than valley practice , and in 90 days , 120 days and 150 days the % N transfer was almost same in two different crops maize (1.206 ±0.015-1.124±0.015 %)and paddy (1.204 ±0.025–1.208 ±0.025 %) , whereas the P (%) transfer was highest during 150 days and 180 days followed by more P (%) transfer in maize plants i.e and paddy (0.127±0.005-0.142±0.005%)

(Fig-12) .Whereas K (%) transfer was more in 180 days than other periods i.e. (0.989±0.045 %) in maize and (0.817±0.095 %) in paddy crops (Fig-13) .In jhum practice the N(%) transfer was highest in 180 days both in maize (1.304 ±0.05 %) and paddy (1.297±0.05 %) in double number of inoculated (200) spore treatments and was less in half number of inoculated (100) spore treatments .It was found that P (%) transfer in jhum practice soil was more in 60 days i.e (1.103.±0005) % in potato , (1.127±0.005) % in maize and (1.216±0.035) % in paddy crops and which was the highest transfer (%) followed by other time intervals (Fig-14) . The K (%) transfer was found more in maize plants i.e (1.223±0.015 %) in 180 days in double number of inoculated treatments followed by less transfer rate in other periods (Fig-14) .

In the mixed cropping systems (potato, maize and paddy grown together), it was found that from 150 days to 180 days only in maize plants the transfer rate was more , whereas potato and paddy plants were having stunted growth . In valley land soil , the transfer of N (%) in both maize and paddy plants were higher than potato i.e maize (1.238±0.058 %) and paddy (1.206±0.052)% (Fig-15) . Whereas P (%) transfer was almost same i.e (0.10±0.005-0.13±0.005) % in 120 and 150 days . The K (%) transfer was higher in double number of inoculated spore treatments (Fig-15) . In mixed cropping system of terrace land soil the N (%) transfer was more in maize plants (1.121±0.045%-1.208±0.045 %) and was less in potato and paddy crops whereas in 90 days the P (%) transfer was (0.123±0.005) % in potato crops and the K (%) transfer was higher in 90 days i.e (0.129±0.015) % in maize plants followed by less transfer rate in other periods (Fig-16) as compared with control treatments . In jhum land soil condition of mixed cropping system, it was found that N (%) transfer was more starting from 30 days to 90 days i.e (0.812±0.055–1.301±0.055) % in all

the three crops , whereas P (%) transfer in 60 days was more i.e (0.801±0.005-1.230±0.005 %) in three crops (Fig-17) .The K (%) transfer was highest in 180 days maize plants i.e (1.001±0.005-1.230±0.005 %) than less in all other periods. It was observed from the comparative study of both pure and mixed cropping systems that the transfer of nutrients i.e (N, P, and K) in pure cropping systems were more than mixed cropping systems for all the three separate crops , and the experimental observation showed that in control treatments, the growth and uptake of nutrients were less followed by more in double number (Z) and half number (Y) spore inoculated treatments and it was found in both mixed and pure cropping systems the transfer of nutrients during spore inoculated treatments were comparatively more in double number of inoculated treatments.It was observed that right after inoculation of VAM spores i.e 0-15 days the nutrient uptake was nil , whereas starting from 30-180 days the nutrient uptake from soil to plants gradually increased and the inoculated spores started multiplying also. It was seen that the nutrient uptake was more in more inoculated spore treatments in three crops, which showed positive correlation i.e (significant at 1 % and 5 % respectively). Whereas after 180 days even if the spore number increased the nutrient uptake in three agricultural fields and crops did not show the significance in both pure and mixed cropping systems .It was seen that in three field conditions in three different crops and in three different treatment levels the nutrient uptake rate i.e N(%), P(%) and K(%) was mostly positively correlated among each other from 30-120 days both in pure and mixed cropping systems (Significant at 1 % and 5 % respectively). (Table- 10-27).

Discussion

It was found that in both pure and mixed cropping systems the transfer of nutrients (N, P, and K) from different soil conditions i.e valley, terrace and jhum land to three different crops i.e potato, maize and paddy was more in double number (Z) of spore inoculated treatments and moderate in half number (Y) of spore inoculated treatments and least in control treatments (X) which may be due to the presence of inoculated VAM spore both in double and half number inoculated treatments, whereas the nutrient uptake was comparatively less in control treatments which may be due to absence of inoculated spores (Omar. ,1996), It was found that in valley and terrace practices the nitrogen (%) transfer from soil to three different crops in both mixed and pure cropping systems was more than jhum practice soil treatments. This may be due to the presence of inoculated spores as well as soil pH (5.06-5.62), whereas in jhum practice soil treatments , the nitrogen (%) transfer was comparatively less which may be due to acidic pH (4.29-4.71) which did not give proper growth to the inoculated VAM spores ,which caused less transfer rate to three different crops (Ibijibijen *et.al.* ,1996). It was also found that the P (%) transfer was more in valley and terrace practice soil treatment which may be due to the inoculated VAM spores.Whereas in control treatments the P (%) transfer was less in all the three crops,which may be due to the non-inoculation of VAM spores and more in inoculated treatments both in pure and mixed cropping systems (Tarafdar and Marschner ,1994). It was also seen that both in mixed and pure cropping systems of three agricultural soil treatments that in the valley and terrace soil treatments the transfer rate was more in maize plants (*Zea mays L.*) followed by less rate in jhum land soil may be due to the presence of VAM spores and the correlation became positive (significant at 1 % and 5 % respectively) (Omar. , 1996).Whereas in jhum practice

soil treatments the transfer rate was comparatively less in maize plants may be due to acidic pH (4.29-4.71), low bulk density (1.1-1.2) mg^{-3} , which did not give suitable atmosphere for the growth of VAM spores (Singh *et al*. , 1991). It was found that in mixed cropping systems starting from 150 days to 180 days , both paddy and potato plants showed stunted growth , whereas in pure cropping systems paddy , potato and maize plants were alive till 180 days which may be due to the micro-climatic situations i.e high growth of maize plants created obstacles for sun light, and temperature followed by paddy and potato crops as well as unequal level of transfer rate and fibrous root systems in potato and paddy crops and adventitious root system in maize plant which caused less growth and death of potato and paddy crops. It was also observed that in double number of spores and half number of inoculated spore treatments in three different crops a positive correlation (significant at 1 % and 5 % respectively) was seen till 90 days may be due to the presence of more VAM spores than control in three different agricultural practices (Wagner *et al* , 2001).It was seen that in three field conditions in three different crops and in three different treatment levels the nutrient uptake was positively correlated among each other from 30-120 days both in pure and mixed cropping system may be due to the inoculated spores, soil nutrients and physiological and functional activities at primary time periods than rest time intervals i.e 150-180 days.

CHAPTER-V

VAM compatibility in different agricultural practices

Introduction

It has been found that in different agricultural systems VAM compatibility either influences or affects the crops, specially the functional compatibility in phosphorus uptake is being influenced by VAM fungal species to a great extent (Ravanskov and Jakobsen., 1995). Sometimes may be due to different physico-chemical and climatic factors, VAM fungi influence the nutrient uptake and growth in different crop systems (Jensen , 1982). The organic matter accumulation and microbial biomass also affect the VAM infection and growth in different crop systems in a zero-tilled crop practice (Dalal and Henderson , 1991). The interactions of VAM infections and presence of certain heavy metals in hilly region disturb the infection rate and stop the nutrient uptake mechanism from root to the various shoot parts to a great extent (Tinker and Gildon ,1983). In acidic and heavy metal deposition rocky soils VAM fungal infection and growth become very slow (Kiliham and Firestone ,1983). VAM fungi are important in productive agriculture , because they improve plant - water relations and also increase mineral uptake by reducing use of fertiliser. The relationship between plants and fungi are important for successful utilization of VAM fungi.The mycorrhizal dependancy of the host plant species or cultivars and the environmental conditions and the overall symbiotic effectiveness is influenced by the functional or physiological compatibility between the two partners (Gianinazzi-Pearson , 1984).Whittingham and Read (1982) observed that nutrient uptake between intraspecific combinations of plants connected by mycorrhizal hyphae could take place in sufficient quantity to provide growth responses in the host plant.The particular abilities of VAM endophytes to change physiological parameters that increase adaptation to low soil water content , which can provide suitable conditions for

the selection of two inoculants. Hyphae of some fungi have been observed to retain viability over a range of cooling rates (Smith and Coulson ,1988). The ability of extraradical mycelia of VAM fungi to survive for a longer period of drought (Jasper *et al.*, 1991) has very important applications for freezing tolerance, since it is an essential condition of dehydration tolerance (Siminovitah and Cloutier, 1983). O' Halloran *et al* (1985) observed that disturbance of an arable zero-tilled reduced the absorption of 'P' by seedlings of *Zea mays. L.*

Materials and Methods

Procedure for inoculum production.-

For the proposed experiment the different VAM fungi were isolated from different agricultural practices by Gerdeman and Nicolson (1963) wet sieving decantation method and identified by Trappe and Schenck (1984) method and inoculated in the sterilized soil filled up in different earthen pots with soil and sand in the ratio 3:1.Potato and onion seeds were sown in the soil sand mixed pots. Regular watering and proper light conditions were given time to time. Before death of infected potato and onion plants , again sterilised potato and onion seeds were sown in the same inoculated pots to maintain the inoculum for the proposed experiment..

For the interspecies interaction of crops from VAM compatibility in three different soils (valley, terrace and jhum practices) in three different crop plants (potato, paddy and maize) , the experiment was conducted in the University net house . The soils from three different fields were collected and sterilised for one hour at 15 psi in an autoclave and transferred to the earthen pots . In each pot, seeds of paddy (10), maize (5) and potato(3) were sown separately as well as in combination . In one set of pots seeds were inoculated with 100

number (Y) of VAM spores (*Glomus*, *Gigaspora* and *Sclerocystis* together) i.e 40 *Glomus species*, 40 *Gigaspora species* and 20 *Sclerocystis* species. . In another set same spores of 200 numbers (Z) were inoculated and in the third set no VAM spores were inoculated i.e. control (X) . Three replicates were maintained for each set . The study was carried out for a period of six months. VAM compatibility inside the root i.e. (number of external hyphae, internal hyphae , vesicles , arbuscules and % infection) and growth of crop plants due to VAM i.e. (length of crop plants , number of leaves) were estimated at 30 days interval. N, P, and K of soils were analysed by total nitrogen (Semimicro-kjeldahl method, Allen, 1974) , Molybdenum blue method , and the flame photometer method respectively. The nutrients i.e. N, P, and K of three different crops (potato , maize and paddy) were also analysed at 30 days interval . The total nitrogen was analysed by semimicro-kjeldahl method (Allen, 1974) and triacid digestion method (Allen, 1974) was followed for the analysis of total P and K.

Plate-9:- Showing net house pot experiment on maize, paddy and potato (pure) crops in valley practice soil.

Plate-10:- Showing net house pot experiment on maize, paddy and potato (pure) crops in terrace practice soil.

Plate-11:- Showing net house pot experiment on maize, paddy and potato (pure) crops in jhum practice soil.

X

Y

Z

PLATE-9

X

Y

Z

PLATE-10

X

Y

Z

PLATE-11

PLATE-12

PLATE-13

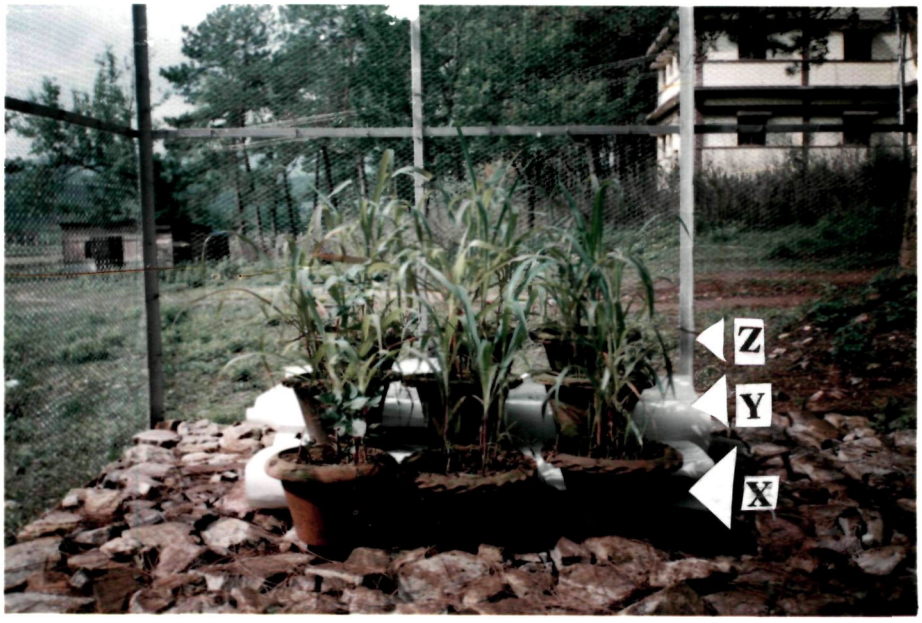


Fig- 18:- Nutrient uptake (N,P and K) of pure cropping system of valley practice soil in net house pot experiment

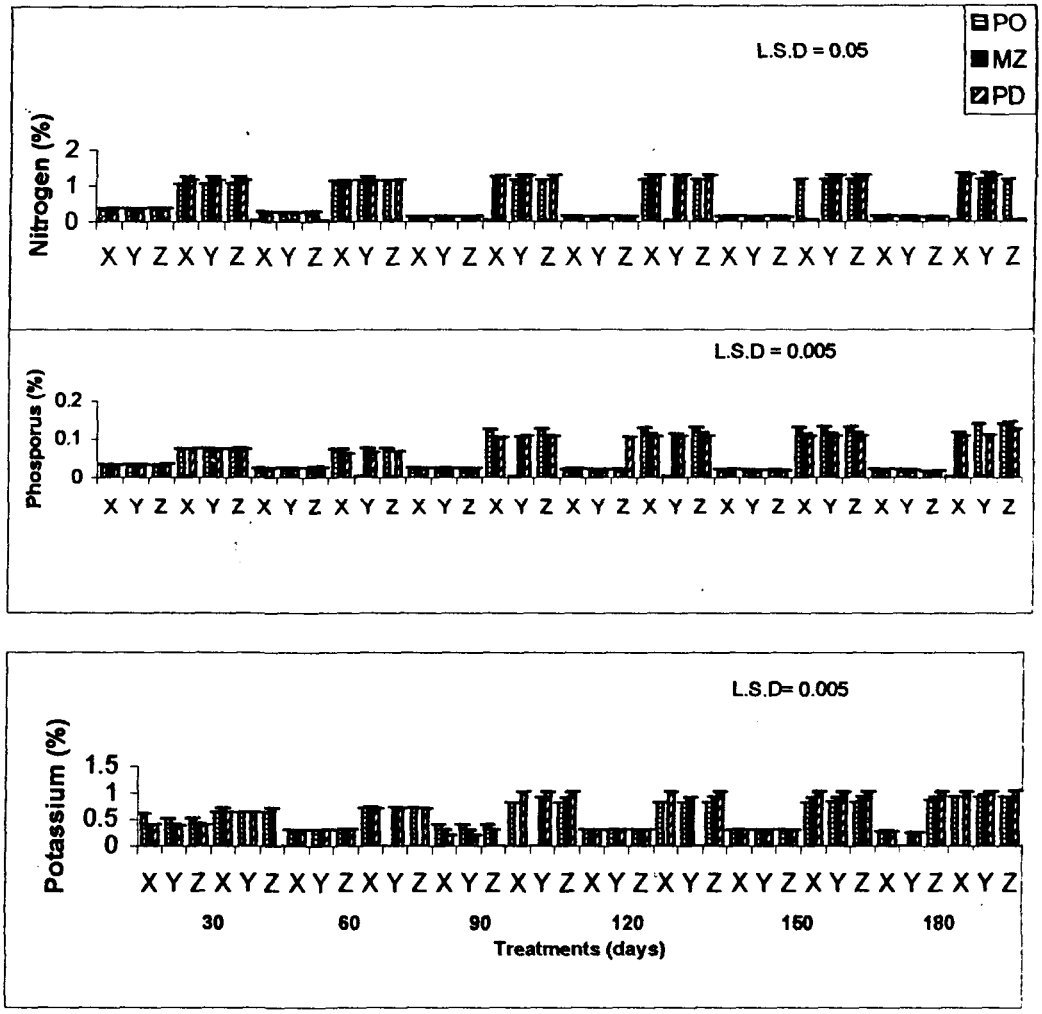


Fig- 19:- Nutrient uptake (N,P and K) of pure cropping system of terrace practice soil in net house pot experiment

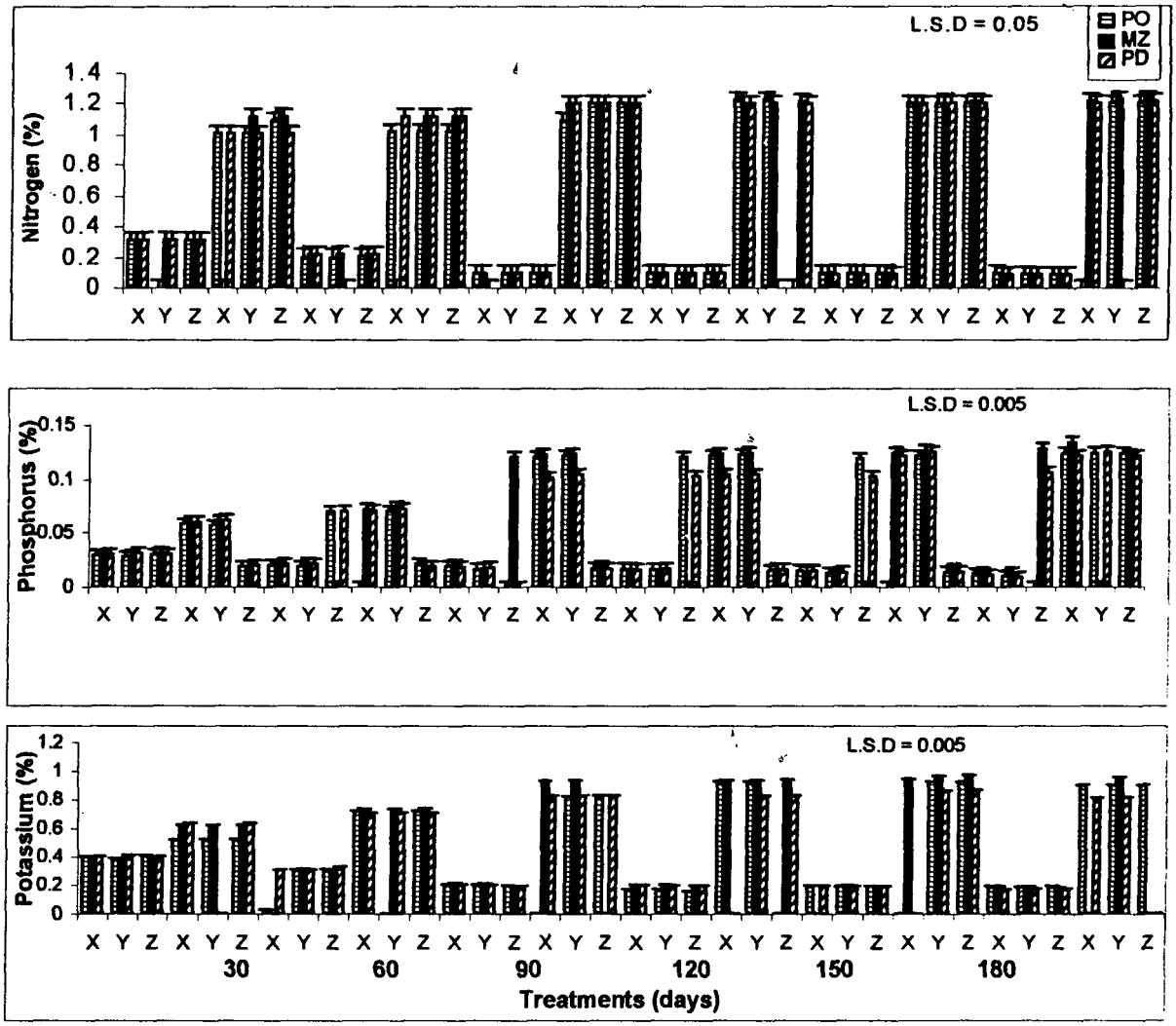


Fig- 20:- Nutrient uptake (N,P and K) of pure cropping system of jhum practice soil in net house pot experiment

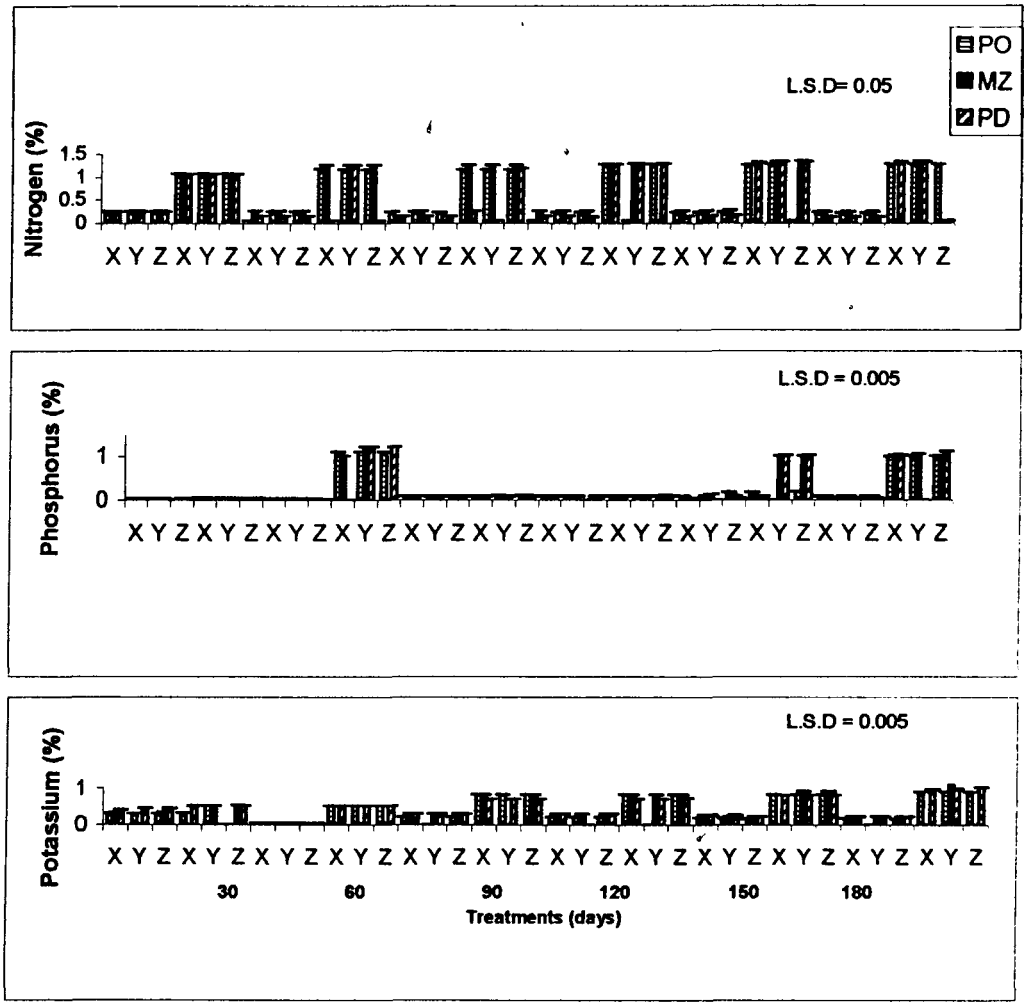


Fig- 21:- Nutrient uptake (N,P and K) of mixed cropping system of valley practice soil in net house pot experiment

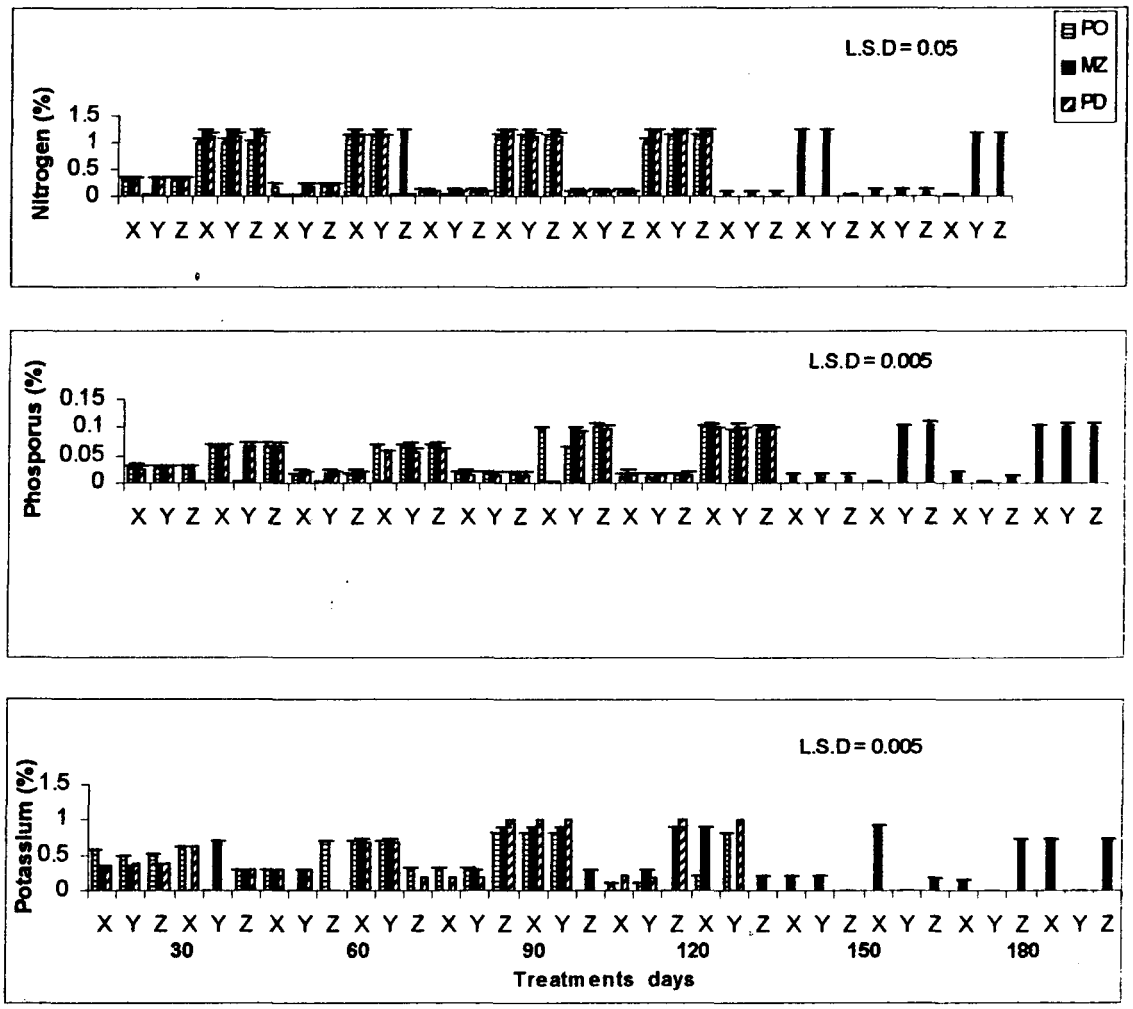


Fig- 22:- Nutrient uptake (N,P and K) of mixed cropping system of terrace practice soil in net house pot experiment

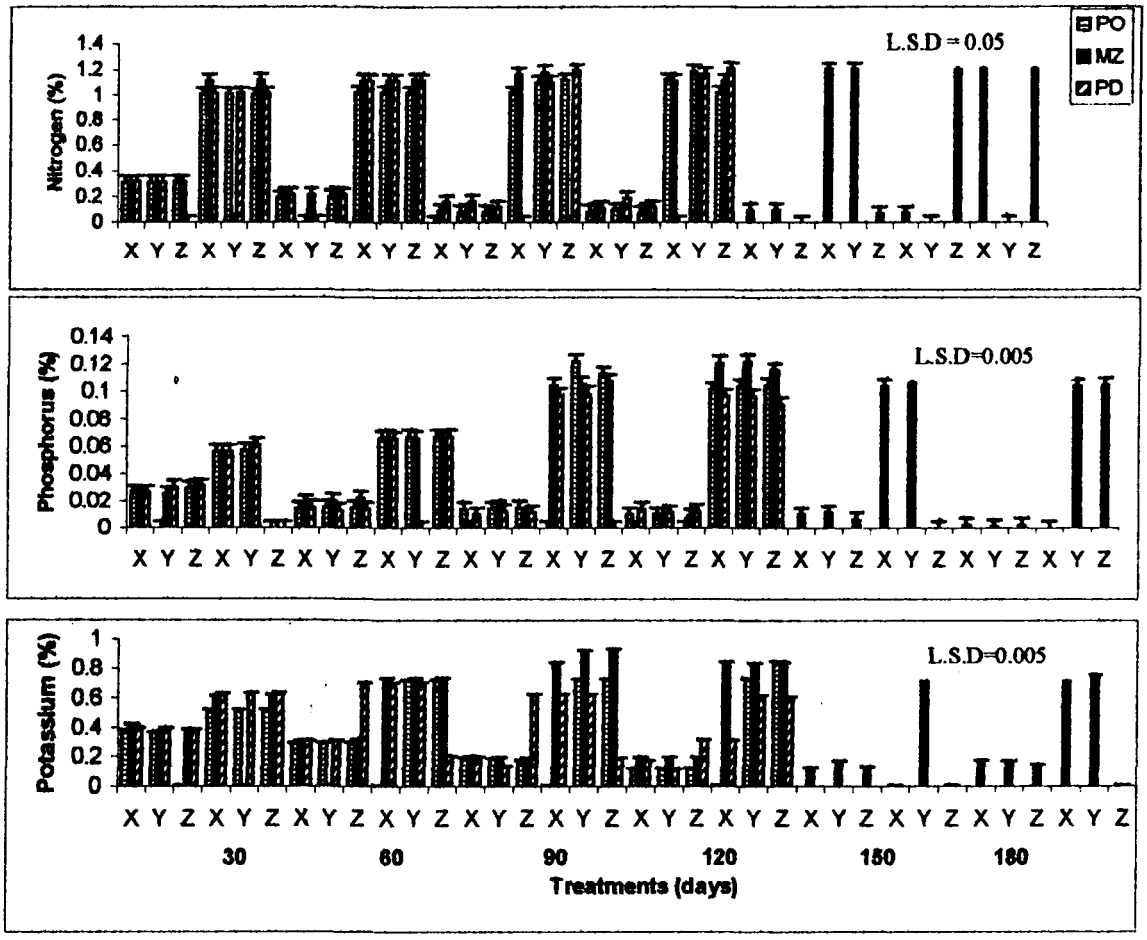


Fig- 23:- Nutrient uptake (N,P and K) of mixed cropping system of jhum practice soil in net house pot experiment

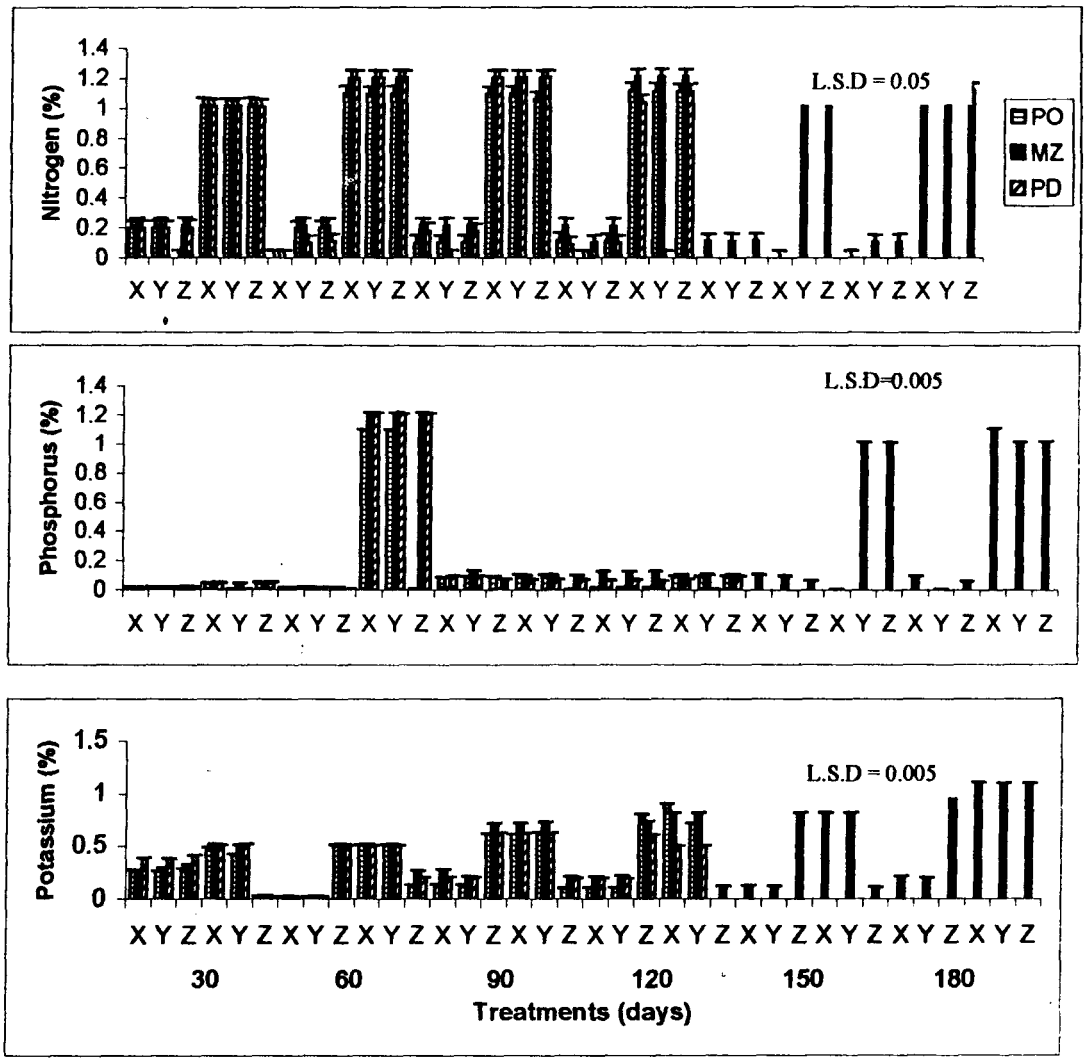


Table- 28 : - Correlation coefficient (r) values among various transfer levels of nitrogen in valley practice soil from 30 to 180 days net house experiment in maize , paddy and potato crops in pure cropping system.

		MZ				
	30d(N%)	60d(N%)	90d(N%)	120d(N%)	150d(N%)	180d(N%)
30d(N%)	*1					
60d(N%)	-0.523	*1				
90d(N%)	0	0.866	*1			
120d(N%)	0.556	0.590	0.866	*1		
150d(N%)	0.567	0.578	0.866	*1	*1	
180d(N%)	0.433	0.563	0.901	**0.997	**0.997	*1
		PD				
	30d(N%)	60d(N%)	90d(N%)	120d(N%)	150d(N%)	180d(N%)
30d(N%)	*1					
60d(N%)	0.981	*1				
90d(N%)	0.970	0.998	*1			
120d(N%)	0.981	*1	0.998	*1		
150d(N%)	*1	0.981	0.970	0.981	*1	
180d(N%)	0.897	0.964	0.977	0.964	0.897	*1
		PO				
	30d(N%)	60d(N%)	90d(N%)	120d(N%)	150d(N%)	180d(N%)
30d(N%)	*1					
60d(N%)	-0.972	*1				
90d(N%)	-0.972	*1	*1			
120d(N%)	-0.461	0.654	0.654	*1		
150d(N%)	-0842	0.944	0.944	0.866	*1	
180d(N%)	-0.601	0.770	0.770	0.986	0.936	*1

*** , ** : - Significant at 1 % and 5 % respectively.**

Table- 29 : - Correlation coefficient (r) values among various transfer levels of phosphorus in valley practice soil from 30 to 180 days net house experiment in maize , paddy and potato crops in pure cropping system.

		MZ				
	30d(P%)	60d(P%)	90d(P%)	120d(P%)	150d(P%)	180d(%P)
30d(P%)	*1					
60d(P%)	0.567	*1				
90d(P%)	0.545	*1	*1			
120d(P%)	*1	0.509	0.599	*1		
150d(P%)	0.866	0.866	0.866	0.866	*1	
180d(%P)	*1	0.589	0.507	*1	0.866	*1
		PD				
	30d(P%)	60d(P%)	90d(P%)	120d(P%)	150d(P%)	180d(%P)
30d(P%)	*1					
60d(P%)	0.866	*1				
90d(P%)	-0.305	0.211	*1			
120d(P%)	0.944	0.981	0.023	*1		
150d(P%)	**0.997	0.998	0.998	0.998	*1	
180d(%P)	0.998	0.923	**0..997	0..996	*1	*1
		PO				
	30d(P%)	60d(P%)	90d(P%)	120d(P%)	150d(P%)	180d(%P)
30d(P%)	*1					
60d(P%)	-0.512	*1				
90d(P%)	0.618	-0.989	*1			
120d(P%)	*1	-05	0.618	*1		
150d(P%)	0.998	0.999	0.009	0.996	*1	
180d(%P)	0.996	**0.997	0.998	**0.997	0.999	*1

*** , ** : - Significant at 1 % and 5 % respectively.**

Table- 30 : - Correlation coefficient (r) values among various transfer levels of potassium in valley practice soil from 30 to 180 days net house experiment in maize, paddy and potato crops in pure cropping system.

		MZ				
	30d(K%)	60d(K%)	90d(K%)	120d(K%)	150d(K%)	180d(K%)
30d(K%)	*1					
60d(K%)	0.998	*1				
90d(K%)	0.976	0.944	*1			
120d(K%)	0.996	0.866	0.981	*1		
150d(K%)	0..999	0.944	*1	0.981	*1	
180d(K%)	0.989	0.999	0.949	0.873	0.949	*1
		PD				
	30d(K%)	60d(K%)	90d(K%)	120d(K%)	150d(K%)	180d(K%)
30d(K%)	*1					
60d(K%)	0.917	*1				
90d(K%)	0.917	*1	*1			
120d(K%)	0.917	*1	*1	*1		
150d(K%)	0.970	0.986	0.986	0.986	*1	
180d(K%)	0.978	0.980	0.980	0.980	0.999	*1
		PO				
	30d(K%)	60d(K%)	90d(K%)	120d(K%)	150d(K%)	180d(K%)
30d(K%)	*1					
60d(K%)	0.981	*1				
90d(K%)	*1	0.981	*1			
120d(K%)	*1	0.981	*1	*1		
150d(K%)	0.509	0.654	0.587	0.509	*1	
180d(K%)	0.866	0.755	0.866	0.866	0.999	*1

*** , ** : - significant at 1 % and 5 % respectively.**

Table- 31 : - Correlation coefficient (r) values among various transfer levels of nitrogen in valley practice soil from 30 to 180 days net house experiment in maize, paddy and potato crops in mixed cropping system.

	30d(N%)	60d(N%)	90d(N%)	120d(N%)	150d(N%)	180d(N%)
30d(N%)	*1					
60d(N%)	*1	*1				
90d(N%)	-0.987	-0.987	*1			
120d(N%)	0.999	0.999	-0.989	*1		
150d(N%)	*1	*1	-0.987	0.999	*1	
180d(N%)	0.939	0.939	-0.981	0.943	0.939	*1
		PD				
	30d(N%)	60d(N%)	90d(N%)	120d(N%)	150d(N%)	180d(N%)
30d(N%)	*1					
60d(N%)	0.866	*1				
90d(N%)	-0.870	-0.507	*1			
120d(N%)	0.989	0.755	-0.947	*1		
150d(N%)	**0.997	0.995	0.999	0.097	*1	
180d(N%)	0.996	0.998	0.098	0.998	**0.997	*1
		PO				
	30d(N%)	60d(N%)	90d(N%)	120d(N%)	150d(N%)	180d(N%)
30d(N%)	*1					
60d(N%)	-0.512	*1				
90d(N%)	-0.123	0.507	*1			
120d(N%)	-0.134	0.509	*1	*1		
150d(N%)	0.998	**0.997	0.994	0.994	*1	
180d(N%)	**0.997	0.999	0.992	**0.997	0.999	*1

*** , ** : - Significant at 1 % and 5 % respectively.**

Table- 32 : -Correlation coefficient (r) values among various transfer levels of phosphorus in valley practice soil from 30 to 180 days net house experiment in maize, paddy and potato crops in mixed cropping system.

		MZ				
	30d(P%)	60d(P%)	90d(P%)	120d(P%)	150d(P%)	180d(%P)
30d(P%)	*1					
60d(P%)	0.512	*1				
90d(P%)	0.556	*1	*1			
120d(P%)	*1	0.556	0.506	*1		
150d(P%)	0.866	0.866	0.866	0.866	*1	
180d(%P)	*1	0.590	0.534	*1	0.866	*1
		PD				
	30d(P%)	60d(P%)	90d(P%)	120d(P%)	150d(P%)	180d(%P)
30d(P%)	*1					
60d(P%)	0.866	*1				
90d(P%)	-0.305	0.211	*1			
120d(P%)	0.944	0.981	0.023	*1		
150d(P%)	0.211	-0.305	0.998	0.995	*1	
180d(%P)	0.981	0.944	**0.997	0.996	*1	*1
		PO				
	30d(P%)	60d(P%)	90d(P%)	120d(P%)	150d(P%)	180d(%P)
30d(P%)	*1					
60d(P%)	-0.523	*1				
90d(P%)	0.618	-0.989	*1			
120d(P%)	*1	-0.5	0.618	*1		
150d(P%)	0.944	0.981	0.211	0.998	*1	
180(P%)	0.211	-0.305	0.981	**0.997	0.944	*1

***, ** : - Significant at 1 % and 5 % respectively**

Table-33 : - Correlation coefficient (r) values among various transfer levels of potassium in valley practice soil from 30 to 180 days net house experiment in maize, paddy and potato crops in mixed cropping system.

		MZ				
	30d(K%)	60d(K%)	90d(K%)	120d(K%)	150d(K%)	180d(K%)
30d(K%)	*1					
60d(K%)	0.885	*1				
90d(K%)	0.999	0.868	*1			
120d(K%)	-0.728	-0.327	-0.753	*1		
150d(K%)	0.534	0.866	0.503	0.188	*1	
180d(K%)	0.885	*1	0.868	-0.327	0.866	*1
		PD				
	30d(K%)	60d(K%)	90d(K%)	120d(K%)	150d(K%)	180d(K%)
30d(K%)	*1					
60d(K%)	-0.866	*1				
90d(K%)	-0.866	*1	*1			
120d(K%)	-0.523	0.866	0.866	*1		
150d(K%)	0.534	-0.753	**0.997	-0.753	*1	
180d(K%)	0.885	0.503	0.998	0.503	-0.327	*1
		PO				
	30d(K%)	60d(K%)	90d(K%)	120d(K%)	150d(K%)	180d(K%)
30d(K%)	*1					
60d(K%)	-0.944	*1				
90d(K%)	0.678	-0.755	*1			
120d(K%)	-0.643	0.858	-0.984	*1		
150d(K%)	-0.523	0.866	0.999	0.998	*1	
180d(K%)	0.534	-0.753	**0.997	0.996	0.996	*1

*** , ** : - Significant at 1 % and 5 % respectively.**

Table- 34: - Correlation coefficient (r) values among various transfer levels of nitrogen in terrace practice soil from 30 to 180 days net house experiment in maize , paddy and potato crops in pure cropping system.

		MZ				
	30d(N%)	60d(N%)	90d(N%)	120d(N%)	150d(N%)	180d(N%)
30d(N%)	*1					
60d(N%)	0.998	*1				
90d(N%)	0.512	0.866	*1			
120d(N%)	0.887	*1	0.866	*1		
150d(N%)	0.506	-0.862	-0.493	-0.862	*1	
180d(N%)	0.999	*1	0.866	*1	-0.862	*1
		PD				
	30d(N%)	60d(N%)	90d(N%)	120d(N%)	150d(N%)	180d(N%)
30d(N%)	*1					
60d(N%)	0.866	*1				
90d(N%)	0.981	0.755	*1			
120d(N%)	0.981	0.755	*1	*1		
150d(N%)	0.523	0.998	0.654	0.654	*1	
180d(N%)	0.902	0.996	0.804	0.804	0.078	*1
		PO				
	30d(N%)	60d(N%)	90d(N%)	120d(N%)	150d(N%)	180d(N%)
30d(N%)	*1					
60d(N%)	0.524	*1				
90d(N%)	-0.216	-0.944	*1			
120d(N%)	0.774	0.944	-0.785	*1		
150d(N%)	0.774	0.944	-0.785	*1	*1	
180d(N%)	0.819	0.917	-0.737	**0.997	**0.997	*1

*, ** : - Significant at 1 % and 5 % respectively.

Table- 35: - Correlation coefficient (r) values among various transfer levels of phosphorus in terrace practice soil from 30 to 180 days net house experiment in maize , paddy and potato crops in pure cropping system.

		MZ				
	30d(P%)	60d(P%)	90d(P%)	120d(P%)	150d(P%)	180d(P%)
30d(P%)	*1					
60d(P%)	0.944	*1				
90d(P%)	0.755	0.928	*1			
120d(P%)	0.755	0.928	*1	*1		
150d(P%)	*1	0.944	0.755	0.755	*1	
180d(p%)	0.609	0.835	0.979	0.979	0.609	*1
		PD				
	30d(P%)	60d(P%)	90d(P%)	120d(P%)	150d(P%)	180d(P%)
30d(P%)	*1					
60d(P%)	-0.866	*1				
90d(P%)	-0.802	0.993	*1			
120d(P%)	-1	0.866	0.802	*1		
150d(P%)	-0.986	0.935	0.889	0.986	*1	
180d(P%)	-0.979	0.948	0.905	0.979	0.999	*1
		PO				
	30d(P%)	60d(P%)	90d(P%)	120d(P%)	150d(P%)	180d(P%)
30d(P%)	*1					
60d(P%)	*1	*1				
90d(P%)	-0.188	-0.188	*1			
120d(P%)	0.567	0.876	0.981	*1		
150d(P%)	-0.589	-0.577	0.944	0.866	*1	
180d(P%)	-0.567	-0.566	0.944	0.866	*1	*1

*** , ** : - Significant at 1 % and 5 % respectively.**

Table- 36: - Correlation coefficient (r) values among various transfer levels of potassium in terrace practice soil from 30 to 180 days net house experiment in maize , paddy and potato crops in pure cropping system.

		MZ				
	30d(K%)	60d(K%)	90d(K%)	120d(K%)	150d(K%)	180d(K%)
30d(K%)	*1					
60d(K%)	0.866	*1				
90d(K%)	0.944	0.981	*1			
120d(K%)	0.821	0.996	0.963	*1		
150d(K%)	0.996	0.902	0.967	0.864	*1	
180d(K%)	0.987	0.933	0.984	0.900	0.996	*1
		PD				
	30d(K%)	60d(K%)	90d(K%)	120d(K%)	150d(K%)	180d(K%)
30d(K%)	*1					
60d(K%)	0.866	*1				
90d(K%)	0.866	*1	*1			
120d(K%)	0.944	0.981	0.981	*1		
150d(K%)	*1	0.866	0.866	0.944	*1	
180d(K%)	0.866	*1	*1	0.981	0.866	*1
		PO				
	30d(K%)	60d(K%)	90d(K%)	120d(K%)	150d(K%)	180d(K%)
30d(K%)	*1					
60d(K%)	0.970	*1				
90d(K%)	0.960	0.866	*1			
120d(K%)	0.960	0.866	*1	*1		
150d(K%)	0.891	0.755	0.981	0.981	*1	
180d(K%)	-0.970	-0.198	-0.866	-0.866	-0.755	*1

*** , ** : -Significat at 1 % and 5 % respectively.**

Table- 37: - Correlation coefficient (r) values among various transfer levels of nitrogen in terrace practice soil from 30 to 180 days net house experiment in maize , paddy and potato crops in mixed cropping system.

		MZ				
	30d(N%)	60d(N%)	90d(N%)	120d(N%)	150d(N%)	180d(N%)
30d(N%)	*1					
60d(N%)	-0.033	*1				
90d(N%)	-0.149	0.993	*1			
120d(N%)	0.233	0.848	0.781	*1		
150d(N%)	0.755	0.628	0.534	0.944	*1	
180d(N%)	0.755	0.628	0.534	0.944	*1	*1
		PD				
	30d(N%)	60d(N%)	90d(N%)	120d(N%)	150d(N%)	180d(N%)
30d(N%)	*1					
60d(N%)	0.998	*1				
90d(N%)	-0.999	-0.036	*1			
120d(N%)	-0.942	0.335	0.929	*1		
150d(N%)	0.754	0.848	0.534	0.998	*1	
180d(N%)	0.755	0.628	0.534	**0.997	0.999	*1
		PO				
	30d(N%)	60d(N%)	90d(N%)	120d(N%)	150d(N%)	180d(N%)
30d(N%)	*1					
60d(N%)	0.644	*1				
90d(N%)	-0.920	-0.295	*1			
120d(N%)	0.972	0.447	-0.986	*1		
150d(N%)	-0.920	0.998	0.098	0.335	*1	
180d(N%)	0.972	0.996	**0.997	0.848	0.987	*1

*** , ** : - Significant at 1 % and 5 % respectively.**

Table- 38: - Correlation coefficient (r) values among various transfer levels of phosphorus in terrace practice soil from 30 to 180 days net house experiment in maize , paddy and potato crops in mixed cropping system.

		MZ				
	30d(P%)	60d(P%)	90d(P%)	120d(P%)	150d(P%)	180d(%P)
30d(P%)	*1					
60d(P%)	-1	*1				
90d(P%)	0.870	-0.870	*1			
120d(P%)	-0.777	0.777	-0.367	*1		
150d(P%)	0.933	-0.933	0.635	-0.951	*1	
180d(%P)	0.933	-0.933	0.635	-0.951	*1	*1
		PD				
	30d(P%)	60d(P%)	90d(P%)	120d(P%)	150d(P%)	180d(%P)
30d(P%)	*1					
60d(P%)	0.590	*1				
90d(P%)	0.860	0.870	*1			
120d(P%)	0,.777	0.564	0.678	*1		
150d(P%)	-0.933	0.998	0.876	0.987	*1	
180d(%P)	-0.933	0.996	**0.997	0.986	0.098	*1
		PO				
	30d(P%)	60d(P%)	90d(P%)	120d(P%)	150d(P%)	180d(%P)
30d(P%)	*1					
60d(P%)	*1	*1				
90d(P%)	-0.994	-0.994	*1			
120d(P%)	-0.188	-0.188	0.081	*1		
150d(P%)	0.860	0.876	0.876	0.987	*1	
180d(%P)	0.777	**0.997	**0.997	0.986	0.009	*1

*** , ** :- Significant at 1 % and 5 % respectively.**

Table- 39: - Correlation coefficient (r) values among various transfer levels of potassium in terrace practice soil from 30 to 180 days net house experiment in maize , paddy and potato crops in mixed cropping system.

		MZ				
	30d(K%)	60d(K%)	90d(K%)	120d(K%)	150d(K%)	180d(K%)
30d(K%)	*1					
60d(K%)	-0.960	*1				
90d(K%)	0.700	-0.871	*1			
120d(K%)	0.891	-0.981	0.948	*1		
150d(K%)	0.986	-0.993	0.809	0.953	*1	
180d(K%)	0.922	-0.993	0.921	**0.997	0.973	*1
		PD				
	30d(K%)	60d(K%)	90d(K%)	120d(K%)	150d(K%)	180d(K%)
30d(K%)	*1					
60d(K%)	0.512	*1				
90d(K%)	0.656	0.981	*1			
120d(K%)	0.409	0.994	0.957	*1		
150d(K%)	0.998	0.996	0.996	0.887	*1	
180d(K%)	0.887	0.998	0.995	0.999	**0.997	*1
		PO				
	30d(K%)	60d(K%)	90d(K%)	120d(K%)	150d(K%)	180d(K%)
30d(K%)	*1					
60d(K%)	0.523	*1				
90d(K%)	0.654	0.981	*1			
120d(K%)	0.943	0.184	0.366	*1		
150d(K%)	0.569	0.678	**0.997	0.897	*1	
180d(K%)	0.567	0.456	0.998	0.567	0.998	*1

*** , ** : - Significant at 1 % and 5 % respectively.**

Table- 40: - Correlation coefficient (r) values among various transfer levels of nitrogen in jhum practice soil from 30 to 180 days net house experiment in maize , paddy and potato crops in pure cropping system.

		MZ				
	30d(N%)	*60d(N%)*	*90d(N%)*	*120d(N%)*	*150d(N%)*	*180d(N%)*
30d(N%)	*1					
60d(N%)	-0.685	*1				
90d(N%)	-0.941	0.891	*1			
120d(N%)	-0.546	0.984	0.797	*1		
150d(N%)	-0.738	**0.997	0.922	0.968	*1	
180d(N%)	-0.872	0.953	0.986	0.885	0.973	*1
		PD				
	30d(N%)	*60d(N%)*	*90d(N%)*	*120d(N%)*	*150d(N%)*	*180d(N%)*
30d(N%)	*1					
60d(N%)	0.866	*1				
90d(N%)	0.755	0.981	*1			
120d(N%)	0.944	0.981	0.928	*1		
150d(N%)	0.602	0.920	0.977	0.830	*1	
180d(N%)	0.944	0.981	0.928	*1	0.830	*1
		PO				
	30d(N%)	*60d(N%)*	*90d(N%)*	*120d(N%)*	*150d(N%)*	*180d(N%)*
30d(N%)	*1					
60d(N%)	-1	*1				
90d(N%)	0.866	-0.866	*1			
120d(N%)	0.523	-0.545	0.866	*1		
150d(N%)	-0.277	0.277	-0.720	-0.970	*1	
180d(N%)	-1	*1	-0.866	-0.578	0.277	*1

*** ,** :- Significant at 1 % and 5 % respectively.**

Table- 41: - Correlation coefficient (r) values among various transfer levels of phosphorus in jhum practice soil from 30 to 180 days net house experiment in maize , paddy and potato crops in pure cropping system.

		MZ				
	30d(P%)	*60d(P%)*	*90d(P%)*	*120d(P%)*	*150d(P%)*	*180d(P%)*
30d(P%)	*1					
60d(P%)	0.946	*1				
90d(P%)	0.981	0.868	*1			
120d(P%)	0.981	0.868	*1	*1		
150d(P%)	0.945	0.999	0.866	0.866	*1	
180d(P%)	-0.188	-0.496	0.987	0.987	-0.499	*1
		PD				
	30d(P%)	*60d(P%)*	*90d(P%)*	*120d(P%)*	*150d(P%)*	*180d(P%)*
30d(P%)	*1					
60d(P%)	*1	*1				
90d(P%)	0.981	0.981	*1			
120d(P%)	*1	*1	0.981	*1		
150d(P%)	0.864	0.864	0.943	0.864	*1	
180d(P%)	0.999	0.999	0.984	0.999	0.871	*1
		PO				
	30d(P%)	*60d(P%)*	*90d(P%)*	*120d(P%)*	*150d(P%)*	*180d(P%)*
30d(P%)	*1					
60d(P%)	0.042	*1				
90d(P%)	*1	0.042	*1			
120d(P%)	0.578	0.886	0.509	*1		
150d(P%)	0.987	0.999	0.998	0.866	*1	
180d(P%)	-0.866	-0.536	-0.866	-0.866	-0.545	*1

*** ,** :- Significant at 1 % and 5 % respectively.**

Table- 42: - Correlation coefficient (r) values among various transfer levels of potassium in jhum practice soil from 30 to 180 days net house experiment in maize , paddy and potato crops in pure cropping system.

		MZ				
	30d(K%)	*60d(K%)*	*90d(K%)*	*120d(K%)*	*150d(K%)*	*180d(K%)*
30d(K%)	*1					
60d(K%)	0.866	*1				
90d(K%)	0.933	0.987	*1			
120d(K%)	0.866	*1	0.987	*1		
150d(K%)	0.981	0.944	0.984	0.944	*1	
180d(K%)	0.938	0.985	0.999	0.985	0.986	*1
		PD				
	30d(K%)	*60d(K%)*	*90d(K%)*	*120d(K%)*	*150d(K%)*	*180d(K%)*
30d(K%)	*1					
60d(K%)	0.002	*1				
90d(K%)	*1	0.002	*1			
120d(K%)	-0.720	-0.695	-0.720	*1		
150d(K%)	0.981	0.191	0.981	-0.838	*1	
180d(K%)	0.995	-0.089	0.995	-0.653	0.960	*1
		PO				
	30d(K%)	*60d(K%)*	*90d(K%)*	*120d(K%)*	*150d(K%)*	*180d(K%)*
30d(K%)	*1					
60d(K%)	0.776	*1				
90d(K%)	-0.629	0	*1			
120d(K%)	0.776	*1	0	*1		
150d(K%)	0.881	0.981	-0.188	0.981	*1	
180d(K%)	0.987	0.866	-0.512	0.866	0.944	*1

*** ,** :- Significant at 1 % and 5 % respectively.**

Table- 43: - Correlation coefficient (r) values among various transfer levels of nitrogen in jhum practice soil from 30 to 180 days net house experiment in maize , paddy and potato crops in mixed cropping system.

		MZ				
	30d(N%)	*60d(N%)*	*90d(N%)*	*120d(N%)*	*150d(N%)*	*180d(N%)*
30d(N%),	*1					
60d(N%)	0.970	*1				
90d(N%)	0.960	0.866	*1			
120d(N%)	0.474	0.671	0.211	*1		
150d(N%)	-0.986	-0.917	-0.993	-0.322	*1	
180d(N%)	0.960	0.866	*1	0.211	-0.993	*1
		PD				
	30d(N%)	*60d(N%)*	*90d(N%)*	*120d(N%)*	*150d(N%)*	*180d(N%)*
30d(N%)	*1					
60d(N%)	-0.720	*1				
90d(N%)	-0.838	0.981	*1			
120d(N%)	-0.996	0.777	0.882	*1		
150d(N%)	0.978	0.956	0.988	0.678	*1	
180d(N%)	0.987	0.967	0.999	0.978	0.987	*1
		PO				
	30d(N%)	*60d(N%)*	*90d(N%)*	*120d(N%)*	*150d(N%)*	*180d(N%)*
30d(N%)	*1					
60d(N%)	0.576	*1				
90d(N%)	-0.738	-0.976	*1			
120d(N%)	-0.997	-0.526	0.691	*1		
150d(N%)	0.999	0.967	0.988	0.999	*1	
180d(N%)	0.987	0.999	0.688	0.677	0.988	*1

*** ,** :- Significant at 1 % and 5 % respectively.**

Table- 44: - Correlation coefficient (r) values among various transfer levels of phosphorus in jhum practice soil from 30 to 180 days net house experiment in maize , paddy and potato crops in mixed cropping system.

		MZ				
	30d(P%)	*60d(P%)*	*90d(P%)*	*120d(P%)*	*150d(P%)*	*180d(%P)*
30d(P%)	*1					
60d(P%)	0.960	*1				
90d(P%)	0.277	.099	*1			
120d(P%)	-0.693	-0.866	0.589	*1		
150d(P%)	-0.668	-0.848	0.529	0.999	*1	
180d(%P)	-0.686	-0.861	0.507	0.999	0.999	*1
		PD				
	30d(P%)	*60d(P%)*	*90d(P%)*	*120d(P%)*	*150d(P%)*	*180d(%P)*
30d(P%)	*1					
60d(P%)	0.960	*1				
90d(P%)	-0.981	-0.995	*1			
120d(P%)	0.884	0.720	-0.780	*1		
150d(P%)	0.987	0.988	0.999	0.876!	*1	
180d(%P)	0.988!	0.999	0.988	0.956	0.978	*1
		PO				
	30d(P%)	*60d(P%)*	*90d(P%)*	*120d(P%)*	*150d(P%)*	*180d(%P)*
30d(P%)	*1					
60d(P%)	0.866	*1				
90d(P%)	-0.589	0	*1			
120d(P%)	*1	0.866	-0.599	*1		
150d(P%)	0.988	0.988	0.988	0.988	*1	
180d(%P)	0.999	0.978	0.999	0.978	0.876	*1

*** ,** :- Significant at 1 % and 5 % respectively.**

Table- 45: - Correlation coefficient (r) values among various transfer levels of potassium in jhum practice soil from 30 to 180 days net house experiment in maize , paddy and potato crops in mixed cropping system.

		MZ				
	30d(K%)	*60d(K%)*	*90d(K%)*	*120d(K%)*	*150d(K%)*	*180d(K%)*
30d(K%)	*1					
60d(K%)	0.755	*1				
90d(K%)	-0.114	0.563	*1			
120d(K%)	-0.937	-0.481	0.452	*1		
150d(K%)	-0.142	-0.755	-0.966	-0.209	*1	
180d(K%)	-0.947	-0.507	0.425	0.999	-0.180	*1
		PD				
	30d(K%)	*60d(K%)*	*90d(K%)*	*120d(K%)*	*150d(K%)*	*180d(K%)*
30d(K%)	*1					
60d(K%)	0.596	*1				
90d(K%)	-0.114	-0.866	*1			
120d(K%)	-0.106	-0.861	*0.999	*1		
150d(K%)	0.098	0.988	0.987	.888	*1	
180d(K%)	0.987	0.999	0.999	0.677	0.956	*1
		PO				
	30d(K%)	*60d(K%)*	*90d(K%)*	*120d(K%)*	*150d(K%)*	*180d(K%)*
30d(K%)	*1					
60d(K%)	-0.852	*1				
90d(K%)	-0.523	0	*1			
120d(K%)	0.999	-0.866	-0.556	*1		
150d(K%)	0.987	0.678	0.345	0.988	*1	
180d(K%)	0.988	0.456	0.876	0.999	0.987	*1

*** ,** :- Significant at 1 % and 5 % respectively.**

Table –46 VAM Compatibility in 30 days pure cropping system

			X	PO							MZ							PD			
Agrl Land	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL /in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL /in cm	NLVS/ in cm
V	0	0	0	0	0	11.30	4	0	0	0	0	0	16.2	5	0	0	0	0	0	10.2	4
T	0	0	0	0	0	8.62	4	0	0	0	0	0	16.5	4	0	0	0	0	0	9.6	4
J	0	0	0	0	0	5.61	4	0	0	0	0	0	15.8	4	0	0	0	0	0	8.7	3
			Y	PO							MZ							PD			
V	18.12	18.68	6.12	8.54	45.23 ± 0.025	11.61	5	16.18	14.82	8.23	7.21	48.16±0.015	16.8	5	19.20 ±0.015	18.50	7.12	8.23	46.23	11.9 ±0.05	5
T	20.23 ± 0.025	16.56	7.23	8.23	42.26	10.92	5	11.26	12.23	10.23	7.20	42.13	16.4 ±0.05	5	18.16	19.32	6.23	7.19	42.58	11.4	5
J	16.36	12..38	5.26	6.10	32.09	7.50	4	10.92	10.54	7.16	6.16	36.26	16	4	13.23	12.18	4.21	5.67	32.19	9.7	4
			Z	PO							MZ							PD			
V	22.13 ± 0.015	30.23 ± 0.025	8.34	10.26	46.56	12.80 ±0.015	5	20.54 ±0.015	16.12	10.50	9.12	41.56±0.05	16.8	5	22.18 ±0.05	20.63 ±0.05	8.50	9.28	48.16±0.05	11.8	6
T	19.14	18.56	11.54 ± 0.025	10.13	48.23 ±0.015	10.60	5	15.68	14.16	11.52	10.15	43.23	16	5	21.06	19.13	8.26	7.23	46.23	10.6	5
J	13.30	14.69	7.36	8.12	33.50	7.80	4	13.03	12.56	8.23	7.06	29.10	16.3	4	16.16	16.78	6.20	6.21	34.23	10.2	4

E.H : External hyphae, I .H : Internal hyphae, V: Vesicle, A: Arbuscule, L.P.L: Length of Plants, N.LVS : Number of Leaves, P.O : Potato, MZ: Maize, PD : Paddy, ± = S.E. , X= Control, Y= 100 VAM spore inoculated, Z= 200 VAM spore inoculated

Table –47 VAM Compatibility in 60 days pure cropping system

			X	PO							MZ							PD			
Agrl Land	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL /in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL /in cm	NLVS/ in cm
V	0	0	0	0	0	16.71	5	0	0	0	0	0	24.3	5	0	0	0	0	0	16.3	5
T	0	0	0	0	0	11.30	4	0	0	0	0	0	22.6	5	0	0	0	0	0	12.3	5
J	0	0	0	0	0	7.20	4	0	0	0	0	0	18.5	4	0	0	0	0	0	9.8	4
			Y	PO							MZ							PD			
V	22.92	24.32 ±0.05	10.23	8.59	56.82 ±0.015	19.77 ±0.025	6	22.50 ±0.015	20.50	11.23 ±0.015	7.16	52.23±0.05	26.8 ±0.05	6	22.32 ±0.025	21.52 ±0.025	11.26	10.32	49.56	18.2	6
T	19.16	19.32	8.21	8.56	51.23	13.60	6	19.28	18.21	10.26	8.23	50.15	24.2	6	20.56	19.23	8.56	8.52	43.23	13.6	6
J	14.62	14.68	6.56	6.36	38.96	10.49	5	16.16	14.23	8.52	6.28	32.36	21.2	5	16.96	14.68	6.23	6.09	35.28	11.2	5
			Z	PO							MZ							PD			
V	26.96 ±0.05	26.23 ±0.05	12.50 ±0.05	10.23 ±0.05	58.50 ±0.05	20.60 ±0.05	6	24.23 ±0.05	22.26	12.52	10.50 ±0.025	56.28±0.05	28.2 ±0.035	6	26.50 ±0.025	22.38 ±0.025	12.52 ±0.025	11.56 ±0.025	56.86±0.05	22.3 ±0.05	7
T	22.76	21.22	9.16	10.25 ±0.05	52.20	16.30	6	21.52	19.68 ±0.05	12.32	10.56	52.56	24.8	6	22.32	21.52	10.23	8.08	52.58	19.3 ±0.05	6
J	16.23	15.16	7.23	6.58	39.26	13.20	5	18.23	16.23	9.08	6.16	36.50	22.3	6	18.78	19.28	8.56	7.06	38.56	12.6	5

E.H : External hyphae, I .H : Internal hyphae, V: Vesicle, A: Arbuscule, L.P.L: Length of Plants, N.LVS : Number of Leaves, P.O : Potato, MZ: Maize, PD : Paddy, ± = S.E. , X= Control, Y= 100 VAM spore inoculated, Z= 200 VAM spore inoculated

Table –48 VAM Compatibility in 90 days pure cropping system

			X	PO							MZ							PD			
Agri Land	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL /in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL /in cm	NLVS/ in cm
V	0	0	0	0	0	22.20	5	0	0	0	0	0	26.2	5	0	0	0	0	0	22.2	5
T	0	0	0	0	0	16.38	4	0	0	0	0	0	24.2	5	0	0	0	0	0	19.2	6
J	0	0	0	0	0	11.32	4	0	0	0	0	0	22.2	4	0	0	0	0	0	13.6	5
			Y	PO							MZ							PD			
V	26.72 ± 0.015	25.22 ± 0.015	12.92	10.79	58.77 ± 0.015	24.31	7	26.29 ± 0.05	22.23	12.56 ± 0.05	11.26	56.26± 0.05	32.2 ± 0.05	7	26.28 ± 0.05	23.56	13.56 ± 0.05	11.28	53.28± 0.05	24.6	7
T	22.32	22.72 ± 0.025	11.18	9.23	53.73	22.31	7	21.23	19.26	11.26	10.28	53.28± 0.05	28.3	7	22.32	21.62	11.23	9.26	50.26	22.6	7
J	18.38	19.77	8.76	8.52	42.79	15.32	5	18.26	16.23	9.52	7.52	36.28	22.4	5	19.58	18.58	8.23	7.52	38.26	16.3	6
			Z	PO							MZ							PD			
V	28.72 ± 0.05	27.82 ± 0.035	14.23 ± 0.035	11.26 ± 0.035	62.48 ± 0.035	26.20 ± 0.05	8	28.23 ± 0.035	24.28 ± 0.015	14.23	12.58 ± 0.05	61.52± 0.025	38.3 ± 0.025	8	28.52 ± 0.025	24.32 ± 0.025	13.26 ± 0.025	12.23 ± 0.035	58.23± 0.05	29.3 ± 0.035	7
T	24.36	23.62	13.22 ± 0.05	10.23 ± 0.05	56.68 ± 0.05	24.50 ± 0.05	8	23.52	21.52	12.69 ± 0.05	12.53 ± 0.035	56.28± 0.035	32.6	8	24.32	23.67	11.28	11.52 ± 0.05	54.22	25.2 ± 0.05	7
J	22.22	21.23	10.23	9.52	43.23	18.30	6	22.23	18.32	10.58	9.08	38.23	28.2	6	19.62	21.11	9.26	8.09	42.28	16.2	6

E.H : External hyphae, I .H : Internal hyphae, V: Vesicle, A: Arbuscule, L.P.L: Length of Plants, N.LVS : Number of Leaves, P.O : Potato, MZ: Maize, PD : Paddy, ± = S.E., X= Control, Y= 100 VAM spore inoculated, Z= 200 VAM spore inoculated

Table –49 VAM Compatibility in 120 days pure cropping system

			X	PO							MZ							PD			
Agrl - Land	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm
V	0	0	0	0	0	23.70	5	0	0	0	0	0	27.3	5	0	0	0	0	0	23.1	5
T	0	0	0	0	0	17.60	5	0	0	0	0	0	24.9	5	0	0	0	0	0	19.9	6
J	0	0	0	0	0	11.91	4	0	0	0	0	0	22.6	4	0	0	0	0	0	13.8	5
			Y	PO							MZ							PD			
V	28.26 ±0.05	27.82	13.68	10.68 ±0.05	62.28 ±0.05	26.20	7	27.22 ± 0.035	24.52 ± 0.035	12.23	11.66 ± 0.05	58.52± 0.035	32.3 ± 0.05	7	27.18 ± 0.025	24.38 ± 0.05	13.82	11.92 ± 0.05	56.82± 0.05	24.8 ± 0.05	7
T	23.52	23.23	11.23	9.23	57.33	22.70	7	23.38	21.52	11.28	10.23	56.26± 0.05	28.4	7	24.32	22.92	11.28	9.28	52.23	22.7	7
J	20.16	21.56	9.26	8.21	43.28	16.29	5	19.56	18.29	10.93	8.52	38.58	22.6	5	21.68	19.62	8.92	8.07	40.28	16.7	6
			Z	PO							MZ							PD			
V	30.12 ±0.05	29.52 ± 0.035	14.09 ±0.05	11.52 ± 0.035	66.21	27.30 ±0.05	8	30.80 ± 0.035	26.56 ± 0.05	14.26 ± 0.05	12.26 ± 0.05	63.28± 0.05	40.1 ± 0.05	8	30.09 ± 0.035	24.82 ± 0.05	13.26 ± 0.035	12.26 ± 0.305	61.59± 0.205	30.2 ± 0.305	7
T	25.26	25.23	13.28	10.68	58.23 ±0.05	25.20 ±0.05	8	25.29 ±0.05	22.13	12.82 ± 0.05	12.98	58.29± 0.05	33.8 ± 0.05	8	26.28 ±0.05	23.56 ± 0.05	11.28	11.39	56.72± 0.05	27.3 ± 0.05	7
J	24.72	21.58	10.23	9.78	46.29	19.70	6	22.82	19.83	11.56	10.23	41.81	30.1	7	21.43	21.50	9.52	9.23	43.82	18.3	6

E.H : External hyphae, I .H : Internal hyphae, V: Vesicle, A: Arbuscule, L.P.L: Length of Plants, N.LVS : Number of Leaves, P.O : Potato, MZ: Maize, PD : Paddy, ± = S.E. , X= Control, Y= 100 VAM spore inoculated, Z= 200 VAM spore inoculated

Table –50 VAM Compatibility in 150 days pure cropping system

Land			X	PO							MZ							PD			
	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL /in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL /in cm	NLVS/ in cm
V	0	0	0	0	0	23.89	5	0	0	0	0	0	27.4	5	0	0	0	0	0	23.2	5
T	0	0	0	0	0	17.90	5	0	0	0	0	0	24.9	5	0	0	0	0	0	19.9	6
J	0	0	0	0	0	11.91	4	0	0	0	0	0	22.7	4	0	0	0	0	0	13.8	5
			Y	PO							MZ							PD			
V	28.18 ±0.05	27.38 ±0.05	13.50	10.82	63.72 ±0.05	27.30 ±0.05	7	27.16 ±0.05	24.21	12.58 ± 0.05	11.06	62.18± 0.05	32.3	7	27.62	24.62	13.21	11.23	58.26	26.2	7
T	24.96	23.96	11.68 ±0.05	9.27± 0.05	57.82	22.71	7	23.23	21.62	11.62	10.52	57.19	28.8 ± 0.05	7	24.31 ± 0.025	22.18 ± 0.025	11.52 ± 0.025	9.79± 0.05	53.28± 0.025	23.1	7
J	20.68	21.78 ±0.05	9.23	9.68	44.21	16.20 ±0.05	5	19.21 ±0.05	18.59 ± 0.05	10.19 ± 0.05	9.21± 0.05	39.20± 0.05	22.6	6	21.18	19.23 ± 0.05	9.26± 0.05	9.09	41.92	18.2	6
			Z	PO							MZ							PD			
V	31.23 ±0.05	29.23 ±0.05	14.68 ±0.05	11.52 ±0.05	66.78 ±0.05	27.31	8	32.40 ±0.05	26.28 ± 0.05	14.16	12.23 ± 0.025	63.81± 0.05	40.1 ± 0.015	8	30.06 ±0.05	24.16 ± 0.05	13.18	12.32	60.76± 0.105	30.2 ± 0.105	7
T	25.26 ±0.05	25.82	13.07	10.38	58.06 ±0.05	25.20	8	25.39	22.52	12.13	12.21	58.26	33.8 ± 0.05	8	26.52	23.21	11.68 ± 0.05	11.52 ± 0.05	57.23	27.3 ± 0.05	7
J	24.70	24.96	10.47	9.56	46.09	17.70 ±0.05	6	22.16	19.23	11.23	10.59	41.18	30.1	7	21.33	21.16	9.23	9.23	43.89	18.3	6

E.H : External hyphae, I .H : Internal hyphae, V: Vesicle, A: Arbuscule, L.P.L: Length of Plants, N.LVS : Number of Leaves, P.O : Potato, MZ: Maize, PD : Paddy, ± = S.E. , X= Control, Y= 100 VAM spore inoculated, Z= 200 VAM spore inoculated

Table –51 VAM Compatibility in 180 days pure cropping system

			X	PO							MZ						PD			
Agrl Land	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL /in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL /in cm	NLVS/ in cm
V	0	0	.0	0	0	23.80 ± 0.05	5	0	0	0	0	0	27.4 ± 0.05	5	0	0	0	0	0	23.2	5
T	0	0	0	0	0	17.90	5	0	0	0	0	0	24.9	5	0	0	0	0	0	19.9	5
J	0	0	0	0	0	11.90	4	0	0	0	0	0	22.7 ± 0.05	4	0	0	0	0	0	13.9	5
			Y	PO							MZ						PD			
V	28,.72 ± 0.05	27.19 ± 0.025	13.23	10.66 ± 0.035	63.59 ± 0.015	27.30 ± 0.05	7	27.18 ± 0.105	24.72 ± 0.05	12.12 ± 0.025	11.89	62.19± 0.05	32.4	7	27.56 ± 0.05	24.12 ± 0.05	12.12	11.59	62.12± 0.05	32.4 ± 0.05	7
T	25.66	23.16	11.81	9.12	57.31 ± 0.05	22.81	7	23.61	21.59	11.52	10.62 ± 0.05	57.26	28.8 ± 0.05	7	23.00	21.14	11.06	10.23 ± 0.05	57.16	28.8	7
J	21.83	21.68	9.21± 0.05	9.26	46.56	16.70	5	20.18	19.32	10.23	9.12	40.23± 0.05	22.7	6	20.21 ± 0.05	19.09 ± 0.05	10.01 ± 0.05	9.66	40.06± 0.05	22.7	6
			Z	PO							MZ						PD			
V	31.23 ± 0.205	29.52 ± 0.105	14.07	11.52 ± 0.025	66.14 ± 0.05	27.30	8	33.54 ± 0.05	26.08 ± 0.025	14.16 ± 0.025	12.16	64.18± 0.05	40.1 ± 0.05	8	31.26	24.06	13.56	12.23	61.78	30.2 ± 0.05	7
T	25.68 ± 0.05	25.16	13.09 ± 0.05	10.23 ± 0.05	59.13	25.20	8	25.61 ± 0.05	22.00	12.11	12.68 ± 0.05	58.96	33.8	8	26.51	23.18	11.52	11.52	58.67	27.3	7
J	24.23	24.23 ± 0.05	10.11	9.18	47.07	19.70	6	22.95	22.18	11.00	10.53	42.00	30.1	7	21.12	21.52	9.12	9.23	43.27	18.3	6

E.H : External hyphae, I .H : Internal hyphae, V: Vesicle, A: Arbuscule, L.P.L: Length of Plants, N.LVS : Number of Leaves, P.O : Potato, MZ: Maize, PD : Paddy, ± = S.E. , X= Control, Y= 100 VAM spore inoculated, Z= 200 VAM spore inoculated

Mixed Cropping System

Table –52 VAM Compatibility in 30 days mixed cropping system

		X	PO					MZ										PD			
Agrl Land	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL /in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL /in cm	NLVS/ in cm
V	0	0	0	0	0	7.80± 0.05	3	0	0	0	0	0	11.2	4	0	0	0	0	0	9.8	4
T	0	0	0	0	0	5.39	3	0	0	0	0	0	9.7	3	0	0	0	0	0	8.2	3
J	0	0	0	0	0	4.20	2	0	0	0	0	0	7.3	2	0	0	0	0	0	6.2	3
		Y	PO					MZ										PD			
V	22.23 ±0.05	19.58 ±0.05	6.21± 0.05	8.16± 0.05	48.16 ±0.05	9.88± 0.05	5	19.21 ±0.05	20.19 ± 0.05	7.21	9.23± 0.05	56.19± 0.05	16.5 ± 0.05	5	18.12 ±0.05	16.16 ± 0.05	5.19	8.21	42.21	11.6	5
T	20.12	18.23	5.16	8.16	42.39	9.60	4	20.92	20.16	6.18± 0.05	8.16	42.16	13.6	4	16.59	17.07	5.18	7.18	38.26	11.3	4
J	13.39	15.95	3.02	5.00	32.76	6.10	3	14.16	15.02	5.06	7.23	33.58± 0.05	9.6 ± 0.05	3	11.08	10.18 ± 0.05	3.06± 0.05	6.13	32.12	8.9	3
		Z	PO					MZ										PD			
V	24.26 ± 0.025	22.18 ±0.05	8.16± 0.205	10.23 ± 0.205	53.92 ±0.05	10.30 ± 0.105	6	22.15 ±0.05	21.23 ± 0.05	8.23	10.18 ± 0.05	58.96	16.6	5	22.51 ± 0.105	18.00	8.19± 0.05	10.15 ± 0.105	48.23± 0.205	11.7	7
T	22.18	19.76	7.21	10.21	49.18	10.30	5	21.62	21.62	8.29± 0.05	9.52	52.91± 0.05	13.8	5	19.50	19.21	7.16	8.00	42.18	11.4	6
J	16.16 ±0.05	18.39 ±0.05	5.21	6.51± 0.05	34.16 ±0.05	7.20	4	16.89	16.18	6.12	8.00	36.21	11.3	4	13.21	13.15	5.23	7.16± 0.05	36.50± 0.05	9.2	4

E.H : External hyphae, I .H : Internal hyphae, V: Vesicle, A: Arbuscule, L.P.L: Length of Plants, N.LVS : Number of Leaves, P.O : Potato, MZ: Maize, PD : Paddy, ± = S.E. , ulated, Z= 200 VAM spore inoculated

Table –53 VAM Compatibility in 60 days mixed cropping system

		X	PO					MZ									PD			
Agrl Land	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm
V	0	0	0	0	0	9.80± 0.05	5	0	0	0	0	0	13.2± 0.05	5	0	0	0	0	0	11.2	5
T	0	0	0	0	0	8.40	4	0	0	0	0	0	10.7	4	0	0	0	0	0	10.2	4
J	0	0	0	0	0	5.21± 0.05	3	0	0	0	0	0	8.2± 0.05	3	0	0	0	0	0	7.1	3
		Y	PO					MZ									PD				
V	24.18± 0.105	20.05± 0.015	8.52± 0.05	11.21± 0.205	53.21± 0.05	13.30	5	22.16± 0.05	20.12	11.21± 0.015	10.12	56.12± 0.05	22.8	5	22.11	18.13	8	10.12	47.16± 0.105	16.2± 0.205	5
T	22.92	19.12	6.11	9.23	46.12± 0.05	11.22	5	20.51	21.23± 0.05	8.21	9.00	48.56	18.3	5	19.06	20.23	7	8.16	42.51	12.3	5
J	15.23	16.16	4.23	6.18± 0.05	38.52	10.31± 0.05	4	16.16± 0.05	18.56	7.23± 0.015	8.06	36.21	12.2± 0.05	4	13.01	12.51	5	6.14	36.23	10.2	4
		Z	PO					MZ									PD				
V	28.26± 0.065	22.52± 0.05	11.21± 0.035	12.15	54.18	18.10	5	26.12	21.00	11.52	10.43	58.00	26.8	6	24.56± 0.05	20.61± 0.05	11	11.51± 0.055	53.00	20.2± 0.065	6
T	23.12	21.00	8.67	10.06	48.10	13.49	6	23.05	22.32± 0.05	9.18± 0.05	10.31± 0.025	49.06± 0.05	22.3± 0.105	5	22.12± 0.05	21.03	10	12.31	48.06± 0.05	14.3	5
J	18.16	19.76± 0.05	5.23	7.58± 0.05	39.52± 0.05	10.60	5	19.00	19.11	8.21	9.16	38.51	14.4	5	16.01	13.05	7	7.12	38.09	12.3	5

E.H : External hyphae, I .H : Internal hyphae, V: Vesicle, A: Arbuscule, L.P.L: Length of Plants, N.LVS : Number of Leaves, P.O : Potato, MZ: Maize, PD : Paddy, ± = S.E. , X= Control, Y= 100 VAM spore inoculated, Z= 200 VAM spore inoculated

Table –54 VAM Compatibility in 90 days mixed cropping system

		X	PO					MZ										PD			
Agrl Land	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm
V	0	0	0	0	0	11.60± 0.05	5	0	0	0	0	0	18.6± 0.05	6	0	0	0	0	0	13.2	5
T	0	0	0	0	0	9.81	5	0	0	0	0	0	16.3	6	0	0	0	0	0	11.3± 0.05	5
J	0	0	0	0	0	7.31	4	0	0	0	0	0	13.2± 0.05	5	0	0	0	0	0	9.2	4
		Y	PO					MZ										PD			
V	26.56± 0.05	22.06± 0.05	10.10	12.01	56.18± 0.05	16.20± 0.05	6	24.21± 0.05	22.01	12.12	10.53	58.09	26.2	6	24.11	20.61	10.51 ± 0.05	11.16	53.23	18.2± 0.05	6
T	24.67	21.52	10.22	11.00± 0.05	48.23	12.33	6	23.26	22.06	10.12	10.21	52.13± 0.05	20.2± 0.05	6	21.00± 0.05	22.37± 0.05	8.16	11.01	49.51 ± 0.305	14.2± 0.05	6
J	18.19	18.53± 0.05	6.03± 0.05	8.16± 0.05	42.12	11.20± 0.05	5	19.91	20.50± 0.05	9.01± 0.045	10.23± 0.05	38.51± 0.045	14.3	5	16.00	15.83	6.31	7.01	38.26	12.3	5
		Z	PO					MZ										PD			
V	30.23± 0.05	22.15	11.52	12.23	58.15± 0.05	21.32	6	28.23± 0.05	24.23	12.16	11.16	62.06	28.2	6	26.23± 0.05	22.00	11.16	12.16	56.91 ± 0.05	22.4	6
T	26.21	22.13	11.21± 0.05	12.21± 0.05	52.23	16.3	6	26.12	22.21± 0.045	11.12± 0.05	11.51± 0.045	56.64± 0.045	24.3	6	22.12	22.26± 0.05	12.11 ± 0.05	13.13	52.52	16.2	6
J	21.00	20.51± 0.05	8.06	9.06	45.21	13.2	5	22.06	21.16± 0.05	8.50	9.96	43.43	16.2	5	18.15± 0.05	16.51	10.04 5	9.96± 0.055	41.16 ± 0.045	13.3	5

E.H : External hyphae, I .H : Internal hyphae, V: Vesicle, A: Arbuscule, L.P.L: Length of Plants, N.LVS : Number of Leaves, P.O : Potato, MZ: Maize, PD : Paddy, ± = S.E. , X= Control, Y= 100 VAM spore inoculated, Z= 200 VAM spore inoculated

Table –55 VAM Compatibility in 120 days mixed cropping system

		X	PO					MZ									PD			
Agrl Land	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm
V	0	0	0	0	0	12.6	5	0	0	0	0	0	20.8	6	0	0	0	0	0	16.2	5
T	0	0	0	0	0	10.3	5	0	0	0	0	0	18.6	6	0	0	0	0	0	13.6	6
J	0	0	0	0	0	8.2	4	0	0	0	0	0	14.6	6	0	0	0	0	0	11.2	4
		Y	PO					MZ										PD			
V	29.18± 0.05	22.50	11.67± 0.05	12.21	57.71	17.2	6	24.31± 0.05	22.19	12.16± 0.05	10.61	56.21	29.3± 0.05	7	24.21	20.21	10.12	11.11	54.23± 0.05	20.3	6
T	24.95	21.21	11.12	11.32± 0.05	48.16± 0.05	13.6± 0.05	6	23.51	20.29	10.32	11.25	53.50± 0.05	22.4± 0.05	7	22.86	22.16	8.06	11.52	50.32± 0.05	16.2	6
J	18.23	18.06± 0.05	8.31± 0.05	8.76± 0.05	43.06	12.2	5	19.71± 0.05	20.31± 0.05	9.15± 0.05	10.31± 0.05	39.79	16.6	5	17.07± 0.05	18.61± 0.05	7.09± 0.05	8.07	40.06	14.2	5
		Z	PO					MZ										PD			
V	32.31± 0.05	22.72± 0.05	12.59	12.56	58.52± 0.05	21.8	6	30.11	26.07	12.00	11.12	62.16± 0.05	30.2± 0.05	6	27.00	22.53	11.18	12.89± 0.05	57.89± 0.05	24.3	6
T	27.52	22.32	12.25	12.21± 0.05	52.31	17.2± 0.05	6	27.13± 0.05	22.10± 0.05	11.12	11.92± 0.05	57.62	26.2	6	23.23± 0.05	23.31± 0.05	12.15± 0.05	13.21	53.76	18.2	6
J	21.71± 0.05	21.81	9.71± 0.05	10.00	45.73	13.7	5	23.52	21.18	8.31	9.77	45.09	18.3± 0.05	5	19.00	18.03	10.31	9.15	42.51	13.9	6

E.H : External hyphae, I .H : Internal hyphae, V: Vesicle, A: Arbuscule, L.P.L: Length of Plants, N.LVS : Number of Leaves, P.O : Potato, MZ: Maize, PD : Paddy, ± = S.E. , X= Control, Y= 100 VAM spore inoculated, Z= 200 VAM spore inoculated

Table –56 VAM Compatibility in 150 days mixed cropping system

		X	PO(AB)					MZ										PD(AB)			
Agrl Land	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm
V								0	0	0	0	0	21.23± 0.05	6							
T								0	0	0	0	0	19.20	6							
J								0	0	0	0	0	16.22± 0.05	6							
		Y	PO(AB)					MZ										PD(AB)			
V								25.28± 0.05	22.21	12.50	10.16± 0.045	58.00± 0.405	30.60± 0.045	7							
T								23.16	21.32± 0.035	10.09± 0.035	11.71	54.09	22.80	7							
J								20.02	20.31	10.23	10.19± 0.05	41.11± 0.05	17.10	6							
		Z	PO(AB)					MZ										PD(AB)			
V								30.16± 0.05	26.50± 0.05	12.29± 0.05	11.00	62.52	30.80	6							
T								27.72	22.76	11.32	11.01	57.71	26.70	6							
J								24.31	21.53± 0.05	9.51± 0.05	10.30	46.56± 0.055	18.8	6							

E.H : External hyphae, I .H : Internal hyphae, V: Vesicle, A: Arbuscule, L.P.L: Length of Plants, N.LVS : Number of Leaves, P.O : Potato, MZ: Maize, PD : Paddy, ± = S.E. , AB : Absent, X= Control, Y= 100 VAM spore inoculated, Z= 200 VAM spore inoculated

Table –57 VAM Compatibility in 180 days mixed cropping system

		X	PO(AB)					MZ									PD(AB)			
Agrl Land	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/cm seg	NLVS/cm seg	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm	No of EH/cm seg	No of IH/cm seg	No of V/cm seg	No of A/cm seg	% inf/cm seg	LPL/in cm	NLVS/ in cm
V								0	0	0	0	0	21.20	6							
T								0	0	0	0	0	19.21	6							
J								0	0	0	0	0	16.32	6							
		Y	PO(AB)					MZ										PD(AB)			
V								25.21± 0.05	22.31± 0.045	12.72	10.12± 0.05	58.51± 0,035	30.84	7							
T								23.00	21.26	10.81	11.33± 0.05	54.98	22.95± 0.05	7							
J								21.26	20.59	10.96	10.06± 0.05	42.83± 0.05	17.60	6							
		Z	PO(AB)					MZ										PD(AB)			
V								31.16± 0.05	26.31± 0.045	12.12± 0.05	11.21	62.23± 0.405	30.80± 0.045	6							
T								23.21	22.52± 0.05	9.23	9.23	47.18	27.21	6							
J								11.26	9.76	8.67	7.26± 0.05	32.23	24.23	5							

E.H : External hyphae, I .H : Internal hyphae, V: Vesicle, A: Arbuscule, L.P.L: Length of Plants, N.LVS : Number of Leaves, P.O : Potato, MZ: Maize, PD : Paddy, ± = S.E. , AB : Absent, X= Control, Y= 100 VAM spore inoculated, Z= 200 VAM spore inoculated

Table-58: - Correlation co-efficient (r) values among various infection levels and growth of crop plants from 30-180 days net house experiment in maize crops(pure) in valley land soil.

	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS
E.H	*1																																									
LH	**0.992	*1																																								
V	*1.00	**0.991	*1																																							
A	*1.0	**0.992	*1.00	*1																																						
%inf	0.946	**0.98	0.945	0.947	*1																																					
LPL	0.980	**0.997	0.979	0.980	**0.992	*1																																				
NLVS							*1																																			
E.H	**0.990	*1.00	**0.990	**0.991	0.982	**0.998		*1																																		
LH	**0.991	*1.00	**0.991	**0.992	0.980	**0.997		*1.00	*1																																	
V	**0.994	*1.00	**0.99	**0.994	0.976	**0.996		*1.000	*1.000	*1																																
A	**0.994	0.970	**0.994	**0.993	0.903	0.950		0.968	0.970	0.975	*1																															
%inf	**0.990	*1.000	**0.990	**0.991	0.982	**0.998		1	*1.00	*1.00	0.97	*1																														
LPL	**0.987	0.958	**0.988	**0.987	0.883	0.935		0.956	0.958	0.964	*0.999	0.956	*1																													
NLVS	0.980	**0.997	0.979	0.980	**0.992	*1.000		**0.998	**0.997	**0.996	0.950	**0.998	0.935	*1.000																												
E.H	**0.990	*1.000	**0.989	**0.990	0.982	**0.998		*1.000	*1.000	*0.999	0.968	*1.000	0.955	**0.998	*1.000																											
LH	**0.992	*1.000	**0.991	**0.992	0.979	**0.997		*1.000	*1.000	*1.000	0.971	*1.000	0.959	**0.997	*1.000	*1.000																										
V	**0.995	*0.999	**0.995	**0.996	0.973	**0.994		*0.999	*0.999	*1.000	0.978	*0.999	0.968	**0.994	*0.999	*1.000	*1.000																									
A	**0.994	*1.000	**0.994	**0.995	0.975	**0.995		*1.000	*1.000	*1.000	0.976	*1.000	0.965	**0.995	*0.999	*1.000	*1.000	*1.000																								
%inf	**0.992	*1.000	**0.992	**0.992	0.979	**0.997		*1.000	*1.000	*1.000	0.971	*1.000	0.960	**0.997	*1.000	*1.000	*1.000	*1.000	*1																							
LPL	0.984	0.952	0.984	0.983	0.872	0.927		0.949	0.951	0.958	**0.998	0.949	*1.000	0.927	0.948	0.953	0.962	0.959	0.953	*1.000																						
NLVS	*0.999	0.986	*0.999	*0.999	0.933	0.971		0.984	0.985	**0.989	**0.997	0.984	**0.993	0.971	0.984	0.986	**0.991	**0.989	0.986	**0.990	*1.000																					
E.H	**0.995	*0.999	**0.995	**0.996	0.973	**0.994		*0.999	*0.999	*1.000	0.978	*0.999	0.967	**0.994	*0.999	*1.000	*1.000	*1.000	*1.000	0.962	**0.991	*1.000																				
LH	**0.991	*1.000	**0.991	**0.991	0.981	**0.998		*1.000	*1.000	*1.000	0.970	*1.000	0.957	**0.998	*1.000	*1.000	*0.999	*1.000	*1.000	0.951	0.985	*0.999	*1																			
V	*0.999	**0.997	**0.998	*0.999	0.962	**0.989		**0.996	**0.997	**0.998	0.986	**0.996	0.977	**0.989	**0.996	**0.997	*0.999	*0.999	**0.997	0.972	**0.996	*0.999	**0.997	*1.000																		
A	**0.991	*1.000	**0.990	**0.991	0.981	**0.998		*1.000	*1.000	*1.000	0.969	*1.000	0.957	**0.998	*1.000	*1.000	*0.999	*1.000	*1.000	0.950	0.985	*0.999	*1.000	**0.997	*1.000																	
%inf	**0.991	*1.000	**0.990	**0.991	0.981	**0.998		*1.000	*1.000	*1.000	0.969	*1.000	0.957	**0.998	*1.000	*1.000	*0.999	*1.000	*1.000	0.951	0.985	*0.999	*1.000	**0.997	*1.000	*1.000																
LPL	0.902	0.839	0.904	0.981	0.715	0.797		0.834	0.838	0.850	0.946	0.834	0.959	0.797	0.833	0.841	0.857	0.851	0.841	0.965	0.919	0.857	0.837	0.878	0.836	0.837	*1.000															
NLVS	**0.991	0.966	**0.992	**0.991	0.896	0.945		0.964	0.966	0.971	*1.000	0.964	*1.000	0.945	0.963	0.967	0.975	0.972	0.967	*0.999	**0.996	0.974	0.965	0.983	0.965	0.965	0.951	*1.000														
E.H	*0.999	**0.997	**0.998	*0.999	0.962	**0.989		**0.996	**0.997	**0.998	0.986	**0.996	0.978	**0.989	**0.996	**0.997	*0.999	**0.998	**0.997	0.973	**0.996	*0.999	**0.997	*1.000	**0.996	**0.997	0.879	0.983	*1.000													
LH	**0.991	*1.000	**0.991	**0.992	0.981	**0.997		*1.000	*1.000	*1.000	0.970	*1.000	0.958	**0.997	*1.000	*1.000	*0.999	*1.000	*1.000	0.951	0.985	*0.999	*1.000	**0.997	*1.000	*1.000	0.838	0.966	**0.997	*1.000												
V	**0.995	*1.000	**0.995	**0.995	0.974	**0.995		*0.999	*1.000	*1.000	0.977	*0.999	0.966	**0.995	*0.999	*1.000	*1.000	*1.000	*1.000	0.960	**0.990	*1.000	*0.999	*0.999	*0.999	*0.999	0.855	0.973	*0.999	*1.000	*1.000											
A	**0.993	*1.000	**0.993	**0.994	0.977	**0.996		*1.000	*1.000	*1.000	0.974	*1.000	0.962	**0.996	*1.000	*1.000	*1.000	*1.000	*1.000	0.956	**0.988	*1.000	*1.000	**0.998	*1.000	*1.000	0.847	0.970	**0.998	*1.000	*1.000	*1.000										
%inf	0.982	**0.998	0.981	0.983	**0.990	*1.000		*0.999	**0.998	**0.997	0.955	*0.999	0.940	*1.000	*0.999	**0.998	**0.996	**0.997	**0.998	0.932	0.974	**0.996	**0.998	**0.991	*0.999	**0.998	0.805	0.949	**0.991	**0.998	**0.996	**0.997	*1.000									
LPL	0.900	0.835	0.901	0.898	0.710	0.793		0.831	0.835	0.847	0.943	0.831	0.958	0.793	0.829	0.837	0.854	0.848	0.838	0.964	0.916	0.853	0.833	0.875	0.832	0.833	*1.000	0.949	0.876	0.834	0.851	0.843	0.802	*1.000								
NLVS	**0.991	0.966	**0.992	**0.991	0.896	0.945		0.964	0.966	0.971	*1.000	0.964	*1.000	0.945	0.963	0.967	0.975	0.972	0.967	*0.999	**0.996	0.974	0.965	0.983	0.965	0.965	0.951	*1.000	0.983	0.966	0.973	0.970	0.949	0.949	*1.000							
E.H	*1.000	**0.994	*1.000	*1.000	0.953	0.984		**0.993	**0.994	**0.996	**0.991	**0.993	0.983	0.984	**0.993	**0.995	**0.997	**0.996	**0.995	0.979	**0.998	**0.997	**0.994	*1.000	**0.994	**0.994	0.892	**0.988	*1.000	**0.994	**0.997	**0.996	0.986	0.889	**0.988	*1.000						
LH	**0.988	*1.000	**0.987	**0.988	0.985	*0.999		*1.000	*1.000	*0.999	0.964	*1.000	0.951	*0.999	*1.000	*1.000	**0.998	*0.999	*1.000	0.943	0.981	**0.998	*1.000	**0.995	*1.000	*1.000	0.824	0.959	**0.995	*1.000	**0.998	*0.999	*0.999	0.821	0.959	**0.991	*1.000					
V	**0.998	**0.998	**0.998	**0.998	0.964	**0.990		**0.997	**0.998	*0.999	0.985	*0.997	0.976	**0.990	**0.997	**0.998	**0.999	*0.999	**0.998	0.970	**0.995	*0.999	**0.997	*1.000	**0.997	**0.997	0.874	0.982	*1.000	**0.998	*0.999	*0.999	**0.992	0.871	0.982	*0.999	**0.996	*1.000				
A	0.983	*0.999	0.982	0.984	**0.989	*1.000		*0.999	*0.999	**0.997	0.956	*0.999	0.942	*1.000	*0.999	**0.998	**0.996	**0.997	**0.998	0.934	0.975	**0.996	*0.999	**0.992	*0.999	*0.999	0.809	0.951	**0.991	*0.999	**0.997	**0.998	*1.000	0.805	0.951	**0.987	*1.000	**0.993	*1.000			
%inf	0.985	*0.999	0.984	0.985	**0.988	*1.000		*0.999	*0.999	**0.998	0.959	*0.999	0.945	*1.000	*0.999	*0.999	**0.997	**0.998	*0.999	0.937	0.977	**0.997	*0.999	**0.993	*0.999	*0.999	0.814	0.954	**0.992	*0.999	**0.997	*0.998	*1.000	0.810	0.954	**0.989	*1.000	**0.994	*1.000	*1.000		
LPL	0.904	0.840	0.905	0.902	0.716	0.799		0.836	0.839	0.852	0.946	0.836	0.960	0.799	0.834	0.842	0.859	0.852	0.843	0.966	0.920	0.858	0.838	0.879	0.837	0.838	*1.000	0.952	0.880	0.839	0.856	0.848	0.807	*1.000	0.952	0.893	0.826	0.875	0.810	0.815	*1.000	
NLVS	**0.991	0.966	**0.992	**0.991	0.896	0.945		0.964	0.966	0.971	*1.000	0.964	*1.000	0.945	0.963	0.967	0.975	0.972	0.967	*0.999	**0.996	0.974	0.965	0.983	0.965	0.965	0.951	*1.000	0.983	0.966	0.973	0.970	0.949	0.949	*1	**0.988	0.959	0.981	0.951	0.953	0.951	*1

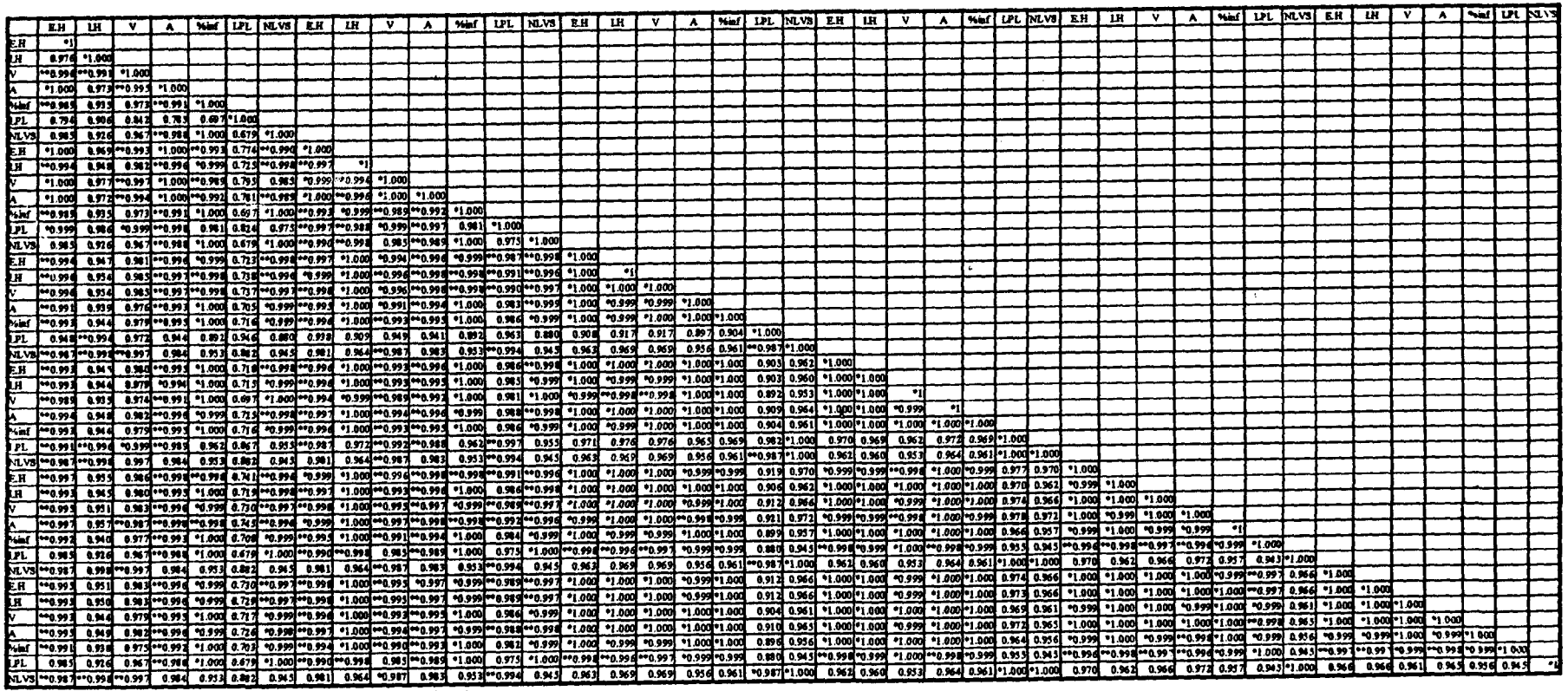
*,** :- Significant at 1 % and 5 % respectively.

Table-59: - Correlation co-efficient (r) values among various infection levels and growth of crop plants from 30-180 days net house experiment in paddy crops(pure) in valley land soil

	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS
E.H	*1																																									
LH	0.976	*1.000																																								
V	**0.996	**0.991	*1.000																																						
A	*1.000	0.973	**0.995	*1.000																																					
%inf	**0.989	0.935	0.973	**0.991	*1.000																																				
LPL	0.794	0.906	0.842	0.785	0.697	*1.000																																			
NLVS	0.985	0.926	0.967	**0.988	*1.000	0.679	*1.000																																		
E.H	*1.000	0.969	**0.993	*1.000	**0.993	0.774	**0.990	*1.000																																	
LH	**0.994	0.948	0.982	**0.996	*0.999	0.725	**0.998	**0.997	*1																																
V	*1.000	0.977	**0.997	*1.000	**0.989	0.795	0.985	*0.999	**0.994	*1.000																															
A	*1.000	0.972	**0.994	*1.000	**0.992	0.781	**0.989	*1.000	**0.996	*1.000	*1.000																														
%inf	**0.989	0.935	0.973	**0.991	*1.000	0.697	*1.000	**0.993	*0.999	**0.989	**0.992	*1.000																													
LPL	*0.999	0.986	*0.999	**0.998	0.981	0.824	0.975	**0.997	**0.988	*0.999	**0.997	0.981	*1.000																												
NLVS	0.985	0.926	0.967	**0.988	*1.000	0.679	*1.000	**0.990	**0.998	0.985	**0.989	*1.000	0.975	*1.000																											
E.H	**0.994	0.947	0.981	**0.996	*0.999	0.723	**0.998	**0.997	*1.000	*0.994	**0.996	*0.999	**0.987	**0.998	*1.000																										
LH	**0.996	0.954	0.985	**0.997	**0.998	0.738	**0.996	*0.999	*1.000	**0.996	**0.998	**0.998	**0.991	**0.996	*1.000	*1																									
V	**0.996	0.954	0.985	**0.997	**0.998	0.737	**0.997	**0.998	*1.000	*0.996	**0.998	**0.998	**0.990	**0.997	*1.000	*1.000	*1.000																								
A	**0.991	0.939	0.976	**0.993	*1.000	0.705	*0.999	**0.995	*1.000	*0.991	**0.994	*1.000	0.983	**0.999	*1.000	*0.999	*0.999	*1.000																							
%inf	**0.993	0.944	0.979	**0.995	*1.000	0.716	*0.999	**0.996	*1.000	**0.993	**0.995	*1.000	0.986	*0.999	*1.000	*0.999	*1.000	*1.000																							
LPL	0.948	**0.994	0.972	0.944	0.892	0.946	0.880	0.938	0.909	0.949	0.941	0.892	0.963	0.880	0.908	0.917	0.917	0.897	0.904	*1.000																			
NLVS	**0.987	**0.998	**0.997	0.984	0.953	0.882	0.945	0.981	0.964	**0.987	0.983	0.953	**0.994	0.945	0.963	0.969	0.969	0.956	0.961	**0.987	*1.000																		
E.H	**0.993	0.945	0.980	**0.995	*1.000	0.718	**0.998	**0.996	*1.000	**0.993	**0.996	*1.000	0.986	**0.998	*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1.000																		
LH	**0.993	0.944	0.979	*0.994	*1.000	0.715	*0.999	**0.996	*1.000	**0.993	**0.995	*1.000	0.985	*0.999	*1.000	*0.999	*0.999	*1.000	*1.000	0.903	0.960	*1.000	*1.000																
V	**0.989	0.933	0.974	**0.991	*1.000	0.697	*1.000	**0.994	*0.999	**0.989	**0.992	*1.000	0.981	*1.000	*0.999	**0.998	**0.998	*1.000	*1.000	0.892	0.953	*1.000	*1.000	*1															
A	**0.994	0.948	0.982	**0.996	*0.999	0.725	**0.998	**0.997	*1.000	**0.994	**0.996	*0.999	0.988	**0.998	*1.000	*1.000	*1.000	*1.000	*1.000	0.909	0.964	*1.000	*1.000	*0.999	*1														
%inf	**0.993	0.944	0.979	**0.995	*1.000	0.716	*0.999	**0.996	*1.000	**0.993	**0.995	*1.000	0.986	*0.999	*1.000	*0.999	*1.000	*1.000	*1.000	0.904	0.961	*1.000	*1.000	*1.000	*1.000	*1.000													
LPL	**0.991	**0.996	*0.999	**0.989	0.962	0.867	0.955	**0.987	0.972	**0.992	**0.988	0.962	**0.997	0.955	0.971	0.976	0.976	0.965	0.969	0.982	*1.000	0.970	0.969	0.962	0.972	0.969	*1.000												
NLVS	**0.987	**0.998	0.997	0.984	0.953	0.882	0.945	0.981	0.964	**0.987	0.983	0.953	**0.994	0.945	0.963	0.969	0.969	0.956	0.961	**0.987	*1.000	0.962	.0.960	0.953	0.964	0.961	*1.000	*1.000											
E.H	**0.997	0.953	0.986	**0.998	**0.998	0.741	**0.996	*0.999	*1.000	**0.996	**0.998	**0.998	**0.991	**0.996	*1.000	*1.000	*1.000	*0.999	*0.999	0.919	0.970	*0.999	*0.999	**0.998	*1.000	*0.999	0.977	0.970	*1.000										
LH	**0.993	0.945	0.980	**0.995	*1.000	0.719	**0.998	**0.997	*1.000	**0.993	**0.996	*1.000	0.986	**0.998	*1.000	*1.000	*1.000	*1.000	*1.000	0.906	0.962	*1.000	*1.000	*1.000	*1.000	*1.000	0.970	0.962	*0.999	*1.000									
V	**0.995	0.951	0.983	**0.996	*0.999	0.730	**0.997	**0.998	*1.000	**0.995	**0.997	*0.999	**0.989	**0.997	*1.000	*1.000	*1.000	*0.999	*1.000	0.912	0.966	*1.000	*1.000	*0.999	*1.000	*1.000	0.974	0.966	*1.000	*1.000	*1.000								
A	**0.997	0.957	**0.987	**0.998	**0.998	0.745	**0.996	*0.999	*1.000	**0.997	**0.998	**0.998	**0.992	**0.996	*0.999	*1.000	*1.000	**0.998	*0.999	0.921	0.972	*0.999	*0.999	**0.998	*1.000	*0.999	0.978	0.972	*1.000	*0.999	*1.000	*1.000							
%inf	**0.992	0.940	0.977	**0.993	*1.000	0.708	*0.999	**0.995	*1.000	**0.991	**0.994	*1.000	0.984	*0.999	*1.000	*0.999	*0.999	*1.000	*1.000	0.899	0.957	*1.000	*1.000	*1.000	*1.000	*1.000	0.966	0.957	*0.999	*1.000	*0.999	*0.999	*1						
LPL	0.985	0.926	0.967	**0.988	*1.000	0.679	*1.000	**0.990	**0.998	0.985	**0.989	*1.000	0.975	*1.000	**0.998	**0.996	**0.997	*0.999	*0.999	0.880	0.945	**0.998	*0.999	*1.000	**0.998	*0.999	0.953	0.945	**0.996	**0.998	**0.997	**0.996	*0.999	*1.000					
NLVS	**0.987	0.998	**0.997	0.984	0.953	0.882	0.945	0.981	0.964	**0.987	0.983	0.953	**0.994	0.945	0.963	0.969	0.969	0.956	0.961	**0.987	*1.000	0.962	0.960	0.953	0.964	0.961	*1.000	*1.000	0.970	0.962	0.966	0.972	0.957	0.945	*1.000				
E.H	**0.995	0.951	0.983	**0.996	*0.999	0.730	**0.997	**0.998	*1.000	**0.995	*0.997	*0.999	**0.989	**0.997	*1.000	*1.000	*1.000	*0.999	*1.000	0.912	0.966	*1.000	*1.000	*0.999	*1.000	*1.000	0.974	0.966	*1.000	*1.000	*1.000	*1.000	*0.999	**0.997	0.966	*1.000			
LH	**0.995	0.950	0.983	**0.996	*0.999	0.729	**0.997	**0.998	*1.000	**0.995	**0.997	*0.999	**0.989	**0.997	*1.000	*1.000	*1.000	*0.999	*1.000	0.912	0.966	*1.000	*1.000	*0.999	*1.000	*1.000	0.973	0.966	*1.000	*1.000	*1.000	*1.000	*1.000	**0.997	0.966	*1.000	*1.000		
V	**0.993	0.944	0.979	**0.995	*1.000	0.717	*0.999	**0.996	*1.000	**0.993	**0.995	*1.000	0.986	*0.999	*1.000	*1.000	*1.000	*1.000	*1.000	0.904	0.961	*1.000	*1.000	*1.000	*1.000	*1.000	0.969	0.961	*0.999	*1.000	*1.000	*0.999	*1.000	*0.999	0.961	*1.000	*1.000	*1.000	
A	**0.995	0.949	0.982	**0.996	*0.999	0.726	*0.998	**0.997	*1.000	**0.994	**0.997	*0.999	**0.988	**0.998	*1.000	*1.000	*1.000	*1.000	*1.000	0.910	0.965	*1.000	*1.000	*0.999	*1.000	*1.000	0.972	0.965	*1.000	*1.000	*1.000	*1.000	*1.000	**0.998	0.963	*1.000	*1.000	*1.000	*1.000
%inf	**0.991	0.938	0.975	**0.992	*1.000	0.703	*0.999	**0.994	*1.000	**0.990	**0.993	*1.000	0.982	*0.999	*1.000	*0.999	*0.999	*1.000	*1.000	0.896	0.956	*1.000	*1.000	*1.000	*1.000	*1.000	0.964	0.956	*0.999	*1.000	*0.999	**0.998	*1.000	*0.999	0.956	*0.998	*0.999	*1.000	*1.000
LPL	0.985	0.926	0.967	**0.988	*1.000	0.679	*1.000	**0.990	**0.998	0.985	**0.989	*1.000	0.975	*1.000	**0.998	**0.996	**0.997	*0.999	*0.999	0.880	0.945	**0.998	*0.999	*1.000	**0.998	*0.999	0.955	0.945	**0.996	**0.998	**0.997	**0.996	*0.999	*1.000	0.945	**0.997	**0.997	*0.999	**0.998
NLVS	**0.987	**0.998	**0.997	0.984	0.953	0.882	0.945	0.981	0.964	*0.987	0.983	0.953	**0.994	0.945	0.963	0.969	0.969	0.956	0.961	*0.987	*1.000	0.962	0.960	0.953	0.964	0.961	*1.000	*1.000	0.970	0.962	0.966	0.972	0.957	0.945	*1.000	0.966	0.966	0.961	0.965

*,** :- Significant at 1 % and 5 % respectively.

Table-60: - Correlation co-efficient (r) values among various infection levels and growth of crop plants from 30-180 days net house experiment in potato crops(pure) in valley land soil



*,** :- Significant at 1 % and 5 % respectively.

Table-61: - Correlation co-efficient (r) values among various infection levels and growth of crop plants from 30-180 days net house experiment in maize crop (pure) in terrace land soil

	EH	LH	V	A	%inf	LPL	NLVS	EH	LH	V	A	%inf	LPL	NLVS	EH	LH	V	A	%inf	LPL	NLVS	EH	LH	V	A	%inf	LPL	NLVS	EH	LH	V	A	%inf	LPL	NLVS	EH	LH	V	A	%inf
EH	*1																																							
LH	**0.989	*1.000																																						
V	0.985	*1.000	*1																																					
A	*1.000	**0.987	0.983	*1.000																																				
%inf	0.968	**0.995	**0.997	0.965	*1.000																																			
LPL	0.949	0.986	**0.989	0.946	**0.998	*1.000																																		
NLVS	0.962	**0.992	**0.995	0.959	*1.000	*0.999	*1.000																																	
EH	0.976	0.932	0.924	0.978	0.890	0.858	0.880	*1																																
LH	0.976	0.932	0.923	0.978	0.890	0.858	0.879	*1	*1																															
V	**0.998	0.979	0.974	*0.999	0.952	0.930	0.945	**0.987	0.986	*1.000																														
A	**0.989	0.956	0.949	**0.991	0.921	0.893	0.912	**0.997	**0.997	**0.996	*1																													
%inf	0.972	**0.996	**0.998	0.970	*1.000	**0.996	*0.999	0.898	0.898	0.958	0.928	*1.000																												
LPL	*1.000	**0.993	**0.989	*0.999	0.975	0.958	0.970	0.969	0.969	**0.996	0.985	0.979	*1.000																											
NLVS	0.962	**0.992	**0.995	0.959	*1.000	*0.999	*1.000	0.880	0.879	0.945	0.912	*0.999	0.970	*1.000																										
EH	0.982	*0.999	*1.000	0.980	**0.998	**0.991	**0.996	0.918	0.918	0.970	0.944	*0.999	**0.987	**0.996	*1.000																									
LH	0.984	*1.000	*1.000	0.982	**0.997	**0.990	**0.995	0.921	0.921	0.972	0.947	**0.998	**0.989	**0.995	*1.000	*1.000																								
V	0.985	*1.000	*1.000	0.983	**0.997	**0.990	**0.995	0.923	0.923	0.974	0.949	**0.998	**0.989	**0.995	*1.000	*1.000	*1.000																							
A	**0.994	**0.999	**0.998	**0.993	**0.989	0.978	0.986	0.947	0.947	**0.987	0.968	**0.992	**0.997	0.986	**0.997	**0.997	**0.998	*1.000																						
%inf	0.974	**0.997	**0.998	0.972	*1.000	**0.996	*0.999	0.901	0.901	0.960	0.930	*1.000	0.980	*0.999	*0.999	*0.999	*0.999	**0.993	*1																					
LPL	0.966	0.917	0.907	0.969	0.870	0.836	0.859	*0.999	*0.999	0.979	**0.994	0.879	0.958	0.859	0.901	0.904	0.907	0.933	0.882	*1																				
NLVS	**0.998	0.979	0.973	*0.999	0.952	0.930	0.945	**0.987	**0.987	*1.000	**0.996	0.957	**0.996	0.945	0.970	0.972	0.973	**0.987	0.959	0.979	*1.000																			
EH	0.979	**0.998	*1.000	0.977	*0.999	0.993	**0.997	0.911	0.911	0.966	0.939	*1.000	0.984	**0.997	*1.000	*1.000	*1.000	**0.995	*1.000	0.893	0.966	*1.000																		
LH	0.968	**0.995	**0.997	0.966	*1.000	**0.998	*1.000	0.891	0.891	0.953	0.921	*1.000	0.975	*1.000	**0.998	**0.997	**0.997	**0.990	*1.000	0.871	0.953	*0.999	*1.000																	
V	0.986	*1.000	*1.000	0.985	**0.996	**0.988	**0.994	0.927	0.926	0.976	0.951	**0.998	**0.991	**0.994	*1.000	*1.000	*1.000	**0.998	**0.998	0.910	0.975	*0.999	**0.996	*1.000																
A	**0.990	*1.000	*0.999	**0.989	**0.993	0.984	**0.990	0.937	0.937	0.981	0.960	**0.995	**0.994	**0.990	*0.999	*0.999	*0.999	*1.000	**0.996	0.921	0.981	**0.998	**0.993	*1.000	*1.000															
%inf	*1	*1	*1	*1	*1	-1		*1.000	*1.000	*1.000	*1.000	*1.000	*1.000		*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	^1.000	*1.000	*1														
LPL	0.933	0.868	0.856	0.936	0.812	0.772	0.798	**0.989	**0.989	0.951	0.973	0.822	0.922	0.798	0.848	0.852	0.855	0.888	0.826	**0.994	0.951	0.839	0.813	0.860	0.874	*1	*1													
NLVS	**0.998	0.979	0.973	*0.999	0.952	0.930	0.945	**0.987	**0.987	*1.000	**0.996	0.957	**0.996	0.945	0.970	0.972	0.973	**0.987	0.959	0.979	*1.000	0.966	0.953	0.975	0.981	*1	0.951	*1.000												
EH	**0.993	*0.999	**0.998	**0.992	**0.991	0.980	**0.988	0.943	0.943	0.985	0.965	**0.993	**0.996	0.988	**0.998	**0.998	**0.998	*1.000	**0.994	0.929	0.985	**0.996	**0.991	*0.999	*1.000	*1	0.883	0.985	*1.000											
LH	0.971	**0.996	**0.998	0.969	*1.000	**0.997	*0.999	0.896	0.896	0.956	0.926	*1.000	0.978	*0.999	*0.999	**0.998	**0.998	**0.991	*1.000	0.877	0.956	*0.999	*1.000	**0.997	**0.995	*1	0.819	0.956	**0.993	*1.000										
V	0.971	**0.996	**0.998	0.969	*1.000	**0.997	*0.999	0.897	0.896	0.957	0.926	*1.000	0.978	*0.999	*0.999	**0.998	**0.998	**0.991	*1.000	0.878	0.956	*0.999	*1.000	**0.997	**0.995	*1	0.820	0.956	**0.993	*1.000	*1.000									
A	**0.989	*1.000	*1.000	**0.987	**0.994	0.985	**0.992	0.933	0.933	0.979	0.957	**0.996	**0.993	**0.992	*0.999	*0.999	*1.000	*0.999	**0.997	0.917	0.979	**0.998	**0.995	*1.000	*1.000	*1	0.869	0.979	*1.000	**0.996	**0.996	*1.000								
%inf	*1.000	*1.000	*1.000	*1.000	*1.000	-1.000		*1.000	*1.000	*1.000	*1.000	*1.000	*1.000		*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1	*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1							
LPL	0.965	0.915	0.905	0.968	0.868	0.834	0.857	*0.999	*0.999	0.978	**0.993	0.877	0.957	0.857	0.899	0.902	0.905	0.932	0.880	*1.000	0.978	0.891	0.869	0.908	0.920	*1	**0.995	0.978	0.927	0.875	0.876	0.916	*1	*1						
NLVS	0.962	**0.992	**0.995	0.959	*1.000	*0.999	*1.000	0.880	0.879	0.945	0.912	*0.999	0.970	*1.000	**0.996	**0.995	**0.995	0.986	*0.999	0.859	0.945	**0.997	*1.000	**0.994	**0.990		0.798	0.945	**0.988	*0.999	*0.999	**0.992		0.857	*1.000					
EH	0.944	0.983	**0.987	0.940	**0.997	*1.000	**0.998	0.849	0.849	0.924	0.883	**0.995	0.953	**0.998	**0.989	**0.988	**0.987	0.974	**0.994	0.826	0.923	**0.991	**0.996	0.985	0.980	-1	0.760	0.923	0.976	**0.995	**0.993	0.982	-1	0.824	**0.998	*1.000				
LH	0.745	0.837	0.850	0.739	0.889	0.917	0.899	0.582	0.582	0.707	0.640	0.880	0.764	0.899	0.857	0.853	0.850	0.812	0.877	0.548	0.706	0.866	0.888	0.845	0.830	-1	0.454	0.706	0.819	0.883	0.882	0.836	-1	0.545	0.899	0.924	*1.000			
V	0.981	*0.999	*1.000	0.979	**0.998	**0.992	**0.997	0.916	0.916	0.969	0.943	*0.999	0.986	**0.997	*1.000	*1.000	*1.000	**0.996	*0.999	0.898	0.969	*1.000	**0.998	*1.000	**0.998	*1	0.845	0.969	**0.997	*0.999	*0.999	*0.999	*1	0.897	**0.997	**0.990	0.860	*1.000		
A	**0.987	*1.000	*1.000	0.985	**0.996	**0.988	**0.994	0.928	0.927	0.976	0.952	**0.997	**0.991	**0.994	*1.000	*1.000	*1.000	**0.998	**0.998	0.911	0.976	*0.999	**0.996	*1.000	*1.000	*1	0.861	0.976	*0.999	**0.997	**0.997	*1.000	*1	0.910	**0.994	0.985	0.844	*1.000	*1.000	
%inf	0.930	0.974	0.979	0.926	**0.992	**0.998	**0.995	0.827	0.827	0.908	0.866	**0.990	0.940	**0.995	0.982	0.981	0.980	0.964	**0.989	0.803	0.907	0.985	**0.992	0.978	0.972	-1	0.734	0.907	0.967	**0.991	**0.991	0.974	-1	0.801	**0.995	*0.999	0.938	0.983	0.977	*1.000
LPL	0.966	0.916	0.906	0.968	0.869	0.835	0.858	*0.999	*0.999	0.979	**0.993	0.878	0.958	0.858	0.900	0.903	0.906	0.932	0.882	*1.000	0.979	0.892	0.870	0.909	0.921	*1	**0.994	0.979	0.928	0.876	0.877	0.917	*1	*1.000	0.858	0.825	0.547	0.898	0.911	0.802
NLVS	0.962	**0.992	**0.995	0.959	*1.000	*0.999	*1.000	0.880	0.879	0.945	0.912	*0.999	0.970	*1.000	**0.996	**0.995	**0.995	0.986	*0.999	0.859	0.945	**0.997	*1.000	**0.994	**0.990		0.798	0.945	**0.988	*0.999	*0.999	**0.992		0.857	*1.000	**0.998	0.899	**0.997	**0.994	**0.995

Table-62: - Correlation co-efficient (r) values among various infection levels and growth of crop plants from 30-180 days net house experiment in paddy crops (pure) in terrace land soil

	E.H	LH	V	A	%inf	LPL	NLVB	E.H	LH	V	A	%inf	LPL	NLVB	E.H	LH	V	A	%inf	LPL	NLVB	E.H	LH	V	A	%inf	LPL	NLVB	E.H	LH	V	A	%inf	LPL	NLVB
E.H	*1																																		
LH	**0.989	*1.000																																	
V	0.985	*1.000	*1																																
A	*1.000	**0.987	0.983	*1.000																															
%inf	0.968	**0.995	**0.997	0.965	*1.000																														
LPL	0.949	0.986	**0.985	0.946	**0.998	*1.000																													
NLVB	0.962	**0.992	**0.995	0.959	*1.000	*0.999	*1.000																												
E.H	0.976	0.932	0.924	0.978	**0.890	0.858	0.880	*1																											
LH	0.976	0.932	0.923	0.978	**0.890	0.858	0.879	*1	*1																										
V	**0.998	0.979	0.974	*0.999	0.952	0.930	0.945	**0.987	0.986	*1.000																									
A	**0.989	0.956	0.949	**0.991	0.921	0.893	0.912	**0.997	**0.997	**0.996	*1																								
%inf	0.972	**0.996	**0.998	0.970	*1.000	**0.996	*0.999	0.898	0.898	0.958	0.928	*1.000																							
LPL	*1.000	**0.993	**0.989	*0.999	0.975	0.958	0.970	0.969	**0.969	0.996	0.985	0.979	*1.000																						
NLVB	0.962	**0.992	**0.995	0.959	*1.000	*0.999	*1.000	0.880	0.879	0.945	0.912	*0.999	0.970	*1.000																					
E.H	0.982	*0.999	*1.000	0.980	**0.998	**0.991	**0.996	0.918	0.918	0.970	0.944	*0.999	**0.987	**0.996	*1.000																				
LH	0.984	*1.000	*1.000	0.982	**0.997	**0.990	**0.995	0.921	0.921	0.972	0.947	**0.998	**0.989	**0.993	*1.000	*1.000																			
V	0.985	*1.000	*1.000	0.983	**0.997	**0.990	**0.995	0.923	0.923	0.974	0.949	**0.998	**0.989	**0.993	*1.000	*1.000	*1.000																		
A	**0.994	*0.999	**0.998	**0.993	**0.989	0.978	0.986	0.947	0.947	**0.987	0.968	**0.992	**0.997	0.986	**0.997	**0.997	**0.998	*1.000																	
%inf	0.974	**0.997	**0.998	0.972	*1.000	**0.996	*0.999	0.901	0.901	0.960	0.930	*1.000	0.980	*0.999	*0.999	*0.999	*0.999	**0.993	*1																
LPL	0.966	0.917	0.907	0.969	0.870	0.836	0.859	*0.999	*0.999	0.979	**0.994	0.879	0.958	0.859	0.901	0.904	0.907	0.933	0.882	*1															
NLVB	**0.998	0.979	0.973	*0.999	0.952	0.930	0.945	**0.987	**0.987	*1.000	**0.996	0.957	**0.996	0.945	0.970	0.972	0.973	**0.987	0.959	0.979	*1.000														
E.H	0.979	**0.998	*1.000	0.977	*0.999	**0.993	**0.997	0.911	0.911	0.966	0.939	*1.000	0.984	**0.997	*1.000	*1.000	*1.000	**0.995	*1.000	0.893	0.966	*1.000													
LH	0.968	**0.995	**0.997	0.966	*1.000	**0.996	*1.000	0.891	0.891	0.953	0.921	*1.000	0.973	*1.000	**0.998	**0.997	**0.997	**0.990	*1.000	0.871	0.953	*0.999	*1.000												
V	0.986	*1.000	*1.000	0.985	**0.996	0.988	**0.994	0.927	0.926	0.976	0.951	**0.998	**0.991	**0.994	*1.000	*1.000	*1.000	**0.998	**0.998	0.910	0.975	*0.999	**0.996	*1.000											
A	**0.990	*1.000	*0.999	**0.989	**0.993	0.984	**0.990	0.937	0.937	0.981	0.960	**0.995	**0.994	**0.990	*0.999	*0.999	*0.999	*1.000	**0.996	0.921	0.981	**0.998	**0.993	*1.000	*1.000										
%inf	*1	*1	*1	*1	*1	-1		*1.000	*1.000	*1.000	*1.000	*1.000	*1.000		*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1										
LPL	0.933	0.868	0.856	0.936	0.812	0.772	0.798	**0.989	**0.989	0.951	0.975	0.822	0.922	0.798	0.848	0.852	0.855	0.888	0.826	0.994	0.951	0.839	0.813	0.860	0.874	*1	*1								
NLVB	**0.998	0.979	0.973	*0.999	0.952	0.930	0.945	**0.987	**0.987	*1.000	**0.996	0.957	**0.996	0.945	0.970	0.972	0.973	**0.987	0.959	0.979	*1.000	0.966	0.953	0.975	0.981	*1	0.951	*1.000							
E.H	**0.993	*0.999	0.998	**0.992	**0.991	0.980	**0.988	0.943	0.943	0.985	0.965	**0.993	**0.996	**0.988	**0.998	**0.998	**0.998	*1.000	**0.996	0.929	0.985	**0.998	**0.991	*0.999	*1.000	*1	0.883	0.985	*1.000						
LH	0.971	**0.996	**0.998	0.969	*1.000	**0.997	*0.999	0.896	0.896	0.956	0.926	*1.000	0.978	*0.999	*0.999	**0.998	**0.998	**0.991	*1.000	0.877	0.956	*0.999	*1.000	**0.997	**0.995	*1	0.819	0.956	**0.993	*1.000					
V	0.971	**0.996	**0.998	0.969	*1.000	**0.997	*0.999	0.897	0.896	0.957	0.926	*1.000	0.978	*0.999	*0.999	**0.998	**0.998	**0.991	*1.000	0.878	0.956	*0.999	*1.000	**0.997	**0.995	*1	0.820	0.956	**0.993	*1.000	*1.000				
A	**0.989	*1.000	*1.000	0.987	**0.994	0.985	**0.992	0.933	0.933	0.979	0.957	**0.996	**0.993	**0.992	*0.999	*0.999	*1.000	*0.999	**0.997	0.917	0.979	**0.998	**0.995	*1.000	*1.000	*1	0.869	0.979	*1.000	**0.996	**0.996	*1.000			
%inf	*1.000	*1.000	*1.000	*1.000	*1.000	-1.000		*1.000	*1.000	*1.000	*1.000	*1.000	*1.000		*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1	*1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1		
LPL	0.965	0.915	0.905	0.968	0.868	0.834	0.857	*0.999	*0.999	0.978	**0.993	0.877	0.957	0.857	0.899	0.902	0.905	0.932	0.880	*1.000	0.978	0.891	0.869	0.908	0.920	*1	**0.995	0.978	0.927	0.875	0.876	0.916	*1	*1	
NLVB	0.962	0.992	**0.995	0.959	*1.000	*0.999	*1.000	0.880	0.879	0.945	0.912	*0.999	0.970	*1.000	**0.996	**0.995	**0.995	0.986	*0.999	0.859	0.945	**0.997	*1.000	**0.994	**0.990		0.798	0.945	**0.988	*0.999	*0.999	**0.992		0.857	*1.000
E.H	0.944	0.983	**0.987	0.940	**0.997	*1.000	**0.998	0.849	0.849	0.924	0.885	**0.995	0.953	**0.998	**0.989	**0.988	**0.987	0.974	**0.994	0.826	0.923	**0.991	**0.996	0.985	0.980	-1	0.760	0.923	0.976	**0.995	**0.995	0.982	-1	0.824	**0.998
LH	0.745	0.837	0.850	0.739	0.889	0.917	0.889	0.582	0.582	0.707	0.640	0.890	0.764	0.899	0.857	0.853	0.850	0.812	0.877	0.548	0.704	0.866	0.888	0.843	0.830	-1	0.454	0.706	0.819	0.883	0.882	0.836	-1	0.545	0.895
V	0.981	*0.999	*1.000	0.979	**0.998	**0.992	**0.997	0.916	0.916	0.969	0.943	*0.999	0.986	**0.997	*1.000	*1.000	*1.000	**0.996	*0.999	0.888	0.969	*1.000	**0.998	*1.000	**0.998	*1	0.845	0.969	**0.997	*0.999	*0.999	*0.999	*1	0.897	**0.997
A	**0.987	*1.000	*1.000	0.985	**0.996	**0.988	**0.994	0.918	0.917	0.976	0.952	**0.997	**0.991	**0.994	*1.000	*1.000	*1.000	**0.998	**0.998	0.911	0.976	*0.999	**0.996	*1.000	*1.000	*2	0.861	0.976	*0.999	**0.997	**0.997	*1.000	*2	0.910	**0.994
%inf	0.930	0.974	0.979	0.926	**0.992	**0.998	**0.995	0.827	0.827	0.908	0.866	**0.990	0.940	**0.995	0.982	0.981	0.980	0.964	**0.989	0.803	0.907	0.985	**0.992	0.978	0.972	-1	0.734	0.907	0.967	**0.991	**0.991	0.974	-1	0.801	**0.995
LPL	0.966	0.916	0.906	0.968	0.869	0.825	0.858	*0.999	*0.999	0.979	0.993	0.878	0.958	0.858	0.900	0.903	0.906	0.932	0.882	*1.000	0.979	0.892	0.870	0.909	0.921	*1	**0.994	0.979	0.928	0.876	0.877	0.917	*1	*1.000	0.858
NLVB	0.962	**0.992	**0.995	0.959	*1.000	*0.999	*1.000	0.880	0.879	0.945	0.912	*0.999	0.970	*1.000	**0.996	**0.995	**0.995	0.986	*0.999	0.859	0.945	**0.997	*1.000	**0.994	**0.990		0.798	0.945	**0.988	*0.999	*0.999	**0.992		0.857	*1.000

	%inf	LPL	NLVB
E.H			
LH			
V			
A			
%inf			
LPL	0.825	*1	
NLVB	0.547	0.898	*1
E.H	0.911	0.882	**0.995
LH	0.977	**0.994	**0.995
V	*1.000	0.858	*1
A			
%inf			
LPL			
NLVB			

*,** :- Significant at 1 % and 5 % respectively.

Table -63: - Correlation co-efficient (r) values among various infection levels and growth of crop plants from 30-180 days net house experiment in potato crop (pure) in terrace land soil

	E.H	I.H	V	A	%inf	LPL	NLVB	E.H	I.H	V	A	%inf	LPL	NLVB	E.H	I.H	V	A	%inf	LPL	NLVB	E.H	I.H	V	A	%inf	LPL	NLVB	E.H	I.H	V	A	%inf	LPL	NLVB	E.H	I.H	V	A	%inf	LPL	NLVB
E.H	*1																																									
I.H	0.972	*1.000																																								
V	0.955	0.859	*1.000																																							
A	*1.000	0.972	0.955	*1.000																																						
%inf	**0.998	0.957	0.978	**0.998	*1.000																																					
LPL	0.833	0.680	0.959	0.832	0.863	*1.000																																			
NLVB	**0.992	0.934	0.985	**0.992	**0.997	0.896	*1.000																																		
E.H	**0.998	0.956	0.971	**0.998	*1.000	0.864	**0.998	*1.000																																	
I.H	*1.000	0.963	0.964	*1.000	*1.000	0.849	**0.995	*1.000	*1.000																																
V	*1.000	0.978	0.947	*1.000	**0.997	0.818	**0.988	**0.996	**0.998	*1																															
A	0.984	0.915	**0.993	0.984	**0.993	0.918	*0.999	**0.993	**0.989	0.979	*1.000																														
%inf	*0.999	0.981	0.942	*0.999	**0.995	0.810	0.986	**0.995	**0.998	*1.000	0.976	*1																													
LPL	0.736	0.874	0.502	0.736	0.696	0.237	0.644	0.694	0.715	0.752	0.605	0.762	*1.000																												
NLVB	**0.992	0.934	0.985	**0.992	**0.997	0.896	*1.000	**0.998	**0.995	**0.988	*0.999	0.986	0.644	*1.000																												
E.H	*0.999	0.958	0.969	*0.999	*1.000	0.861	**0.997	*1.000	*1.000	**0.997	**0.992	**0.996	0.698	**0.997	*1.000																											
I.H	*0.999	0.959	0.968	*0.999	*1.000	0.859	**0.997	*1.000	*1.000	**0.997	**0.992	**0.996	0.701	**0.997	*1.000	*1.000																										
V	**0.992	0.936	0.984	**0.992	**0.998	0.895	*1.000	**0.998	**0.996	**0.989	**0.998	**0.987	0.646	*1.000	**0.998	**0.997	*-1.000																									
A	**0.998	0.984	0.936	**0.998	**0.993	0.799	0.983	**0.993	**0.996	*0.999	0.972	*1.000	0.774	0.983	**0.994	**0.994	0.983	*1.000																								
%inf	**0.998	0.956	0.972	**0.998	*1.000	0.865	**0.998	*1.000	*1.000	**0.996	**0.993	**0.995	0.692	**0.998	*1.000	*1.000	**0.998	**0.993	*1.000																							
LPL	0.949	0.997	0.814	0.950	0.930	0.617	0.902	0.929	0.939	0.957	0.878	0.961	0.911	0.902	0.931	0.933	0.904	0.966	0.928	*1.000																						
NLVB	**0.992	0.934	0.985	**0.992	**0.997	0.896	*1.000	0.998	**0.995	**0.988	*0.999	0.986	0.644	*1.000	**0.997	**0.997	*1.000	0.983	**0.998	0.902	*1																					
E.H	**0.998	0.956	0.971	**0.998	*1.000	0.865	**0.998	*1.000	*1.000	**0.996	**0.993	**0.995	0.693	**0.998	*1.000	*1.000	**0.998	**0.993	*1.000	0.929	**0.998	*1.000																				
I.H	**0.995	0.943	0.981	**0.995	*0.999	0.885	*1.000	**0.999	**0.997	**0.992	**0.997	**0.990	0.662	*1.000	*0.999	*0.999	*1.000	**0.987	*0.999	0.912	*1.000	*0.999	*1.000																			
V	**0.992	0.934	0.985	**0.992	**0.997	0.896	*1.000	**0.998	**0.995	**0.988	*0.999	0.986	0.644	*1.000	**0.997	**0.997	*1.000	0.983	**0.998	0.902	*1.000	**0.998	*1.000	*1.000																		
A	*0.999	0.982	0.940	*0.999	**0.995	0.805	0.985	**0.994	**0.997	*1.000	0.975	*1.000	0.767	0.985	**0.995	**0.995	0.985	*1.000	**0.994	0.963	0.985	**0.994	**0.989	0.985	*1.000																
%inf	**0.998	0.958	0.978	**0.998	*1.000	0.862	**0.997	*1.000	*1.000	**0.997	**0.992	**0.995	0.697	**0.997	*1.000	*1.000	**0.998	**0.993	*1.000	0.931	**0.997	*1.000	*0.999	**0.997	**0.995	*1.000															
LPL	0.860	0.956	0.678	0.860	0.830	0.433	0.788	0.828	0.864	0.873	0.756	0.880	0.978	0.788	0.832	0.834	0.790	0.888	0.827	0.977	0.788	0.828	0.803	0.788	0.883	0.830	*1.000													
NLVB	**0.992	0.934	0.985	**0.992	0.997	0.896	*1.000	**0.998	**0.995	**0.988	*0.999	0.986	0.644	*1.000	**0.997	**0.997	*1.000	0.983	**0.998	0.902	*1.000	**0.998	*1.000	*1.000	0.985	**0.997	0.788	*1												
E.H	*0.999	0.958	0.969	*0.999	*1.000	0.861	**0.997	*1.000	*1.000	**0.997	**0.992	**0.996	0.699	**0.997	*1	*1.000	**0.997	**0.994	*1.000	0.932	**0.997	*1.000	**0.999	**0.997	**0.995	*1.000	0.832	**0.997	*1.000											
I.H	**0.996	0.948	0.977	**0.996	*1.000	0.877	*0.999	*1.000	**0.998	**0.994	**0.996	**0.992	0.674	*0.999	*0.999	*0.999	*0.999	**0.985	*1.000	0.919	*0.999	*1.000	*1.000	*0.999	**0.991	*1.000	0.813	*0.999	*0.999	*1.000									
V	**0.993	0.939	0.983	**0.993	**0.998	0.891	*1.000	**0.998	**0.994	**0.990	**0.998	0.988	0.653	*1.000	**0.998	**0.998	*1.000	0.985	*0.999	0.907	*1.000	**0.998	*1.000	*1.000	**0.987	**0.998	0.795	*1.000	**0.998	0.795	*1.000	*1.000							
A	0.970	*1.000	0.854	0.970	0.955	0.673	0.931	0.954	0.962	0.976	0.911	0.979	0.878	0.931	0.956	0.957	0.933	0.983	0.953	**0.997	0.931	0.954	0.940	0.931	0.981	0.955	0.958	0.931	0.956	0.945	0.936	*1.000							
%inf	**0.998	0.955	0.972	**0.998	*1.000	0.867	**0.998	*1.000	*0.999	**0.994	**0.994	**0.994	0.690	**0.998	*1.000	*1.000	**0.998	0.992	*1.000	0.927	**0.998	*1.000	*0.999	**0.998	**0.994	*1.000	0.825	**0.998	*1.000	*1.000	*0.999	0.952	*1.000						
LPL	0.890	0.972	0.714	0.890	0.863	0.488	0.825	0.861	0.873	0.901	0.794	0.907	0.964	0.825	0.864	0.866	0.827	0.913	0.860	0.988	0.825	0.861	0.838	0.825	0.910	0.863	0.998	0.825	0.864	0.847	0.831	0.974	0.858	*1.000					
NLVB	**0.992	0.934	0.985	**0.992	**0.997	0.896	*1.000	**0.998	**0.995	**0.988	*0.999	0.986	0.644	*1.000	**0.997	**0.997	*1.000	0.983	**0.998	0.902	*1.000	**0.998	*1.000	*1.000	0.985	**0.997	0.788	*1.000	**0.997	*0.999	*1.000	0.931	**0.998	0.825	*1				
E.H	*1.000	0.971	0.956	*1.000	*0.999	0.834	**0.992	**0.998	*1.000	*1.000	0.985	*0.999	0.733	**0.992	*0.999	*0.999	**0.993	**0.998	**0.998	0.948	**0.992	**0.998	**0.995	**0.992	*0.999	*0.999	0.858	**0.992	*0.999	**0.997	**0.994	0.969	**0.998	0.888	**0.992	*1.000			
I.H	*0.999	0.960	0.968	*0.999	*1.000	0.858	**0.997	*1.000	*1.000	**0.997	**0.993	**0.996	0.702	**0.997	*1.000	*1.000	**0.997	**0.994	*1.000	0.933	**0.997	*1.000	**0.998	**0.997	**0.995	*1.000	0.835	**0.997	*1.000	**0.999	**0.998	0.957	*1.000	0.867	**0.997	*0.999	*1.000		
V	**0.996	0.946	0.978	**0.996	*0.999	0.880	*0.999	*0.999	**0.998	**0.993	**0.996	**0.991	0.670	*0.999	*0.999	*0.999	*1.000	**0.985	*1.000	0.917	*0.999	*0.999	*1.000	*0.999	**0.990	*0.999	0.809	*0.999	*0.999	*1.000	*1.000	0.964	*1.000	0.864	*0.999	**0.996	*0.999	*1.000	
A	*1.000	0.966	0.962	*1.000	*1.000	0.846	**0.995	*0.999	*1.000	*0.999	**0.988	**0.998	0.718	**0.995	*1.000	*1.000	**0.995	**0.994	*0.999	0.941	**0.995	*0.999	**0.997	**0.995	**0.997	*1.000	0.847	**0.995	*1.000	**0.998	**0.996	0.964	*0.999	0.878	**0.995	*1.000	*1.000	**0.998	*1.000	
%inf	**0.995	0.942	0.981	**0.994	*0.999	0.886	*1.000	*0.999	**0.997	**0.992	**0.997	**0.990	0.661	*1.000	*0.999	**0.998	*1.000	**0.987	*0.999	0.911	*1.000	*0.999	*1.000	*1.000	**0.988	*0.999	0.802	*1.000	*0.999	*1.000	*1.000	0.939	*0.999	0.837	*1.000	**0.995	**0.998	*1.000	**0.997	*1.000
LPL	0.960	0.867	*1.000	0.959	0.974	0.955	**0.988	0.973	0.968	0.952	**0.894	0.947	0.515	**0.988	0.973	0.972	**0.987	0.941	0.973	0.823	0.988	0.975	0.984	**0.988	0.945	0.974	0.681	**0.988	0.973	0.980	0.986	0.862	0.976	0.725	**0.988	0.960	0.972	0.981	0.966	0.984	*1.000
NLVB	**0.992	0.934	0.985	**0.992	**0.997	0.896	*1.000	**0.998	**0.995	**0.988	*0.999	0.986	0.644	*1.000	**0.997	**0.997	*1.000	0.983	**0.998	0.902	*1.000	**0.998	*1.000	*1.000	0.985	**0.997	0.788	*1.000	**0.997	*0.999	*1.000	0.981	**0.998	0.825	*1.000	**0.992	*0.997	**0.999	**0.995	*1.000	**0.988	*1

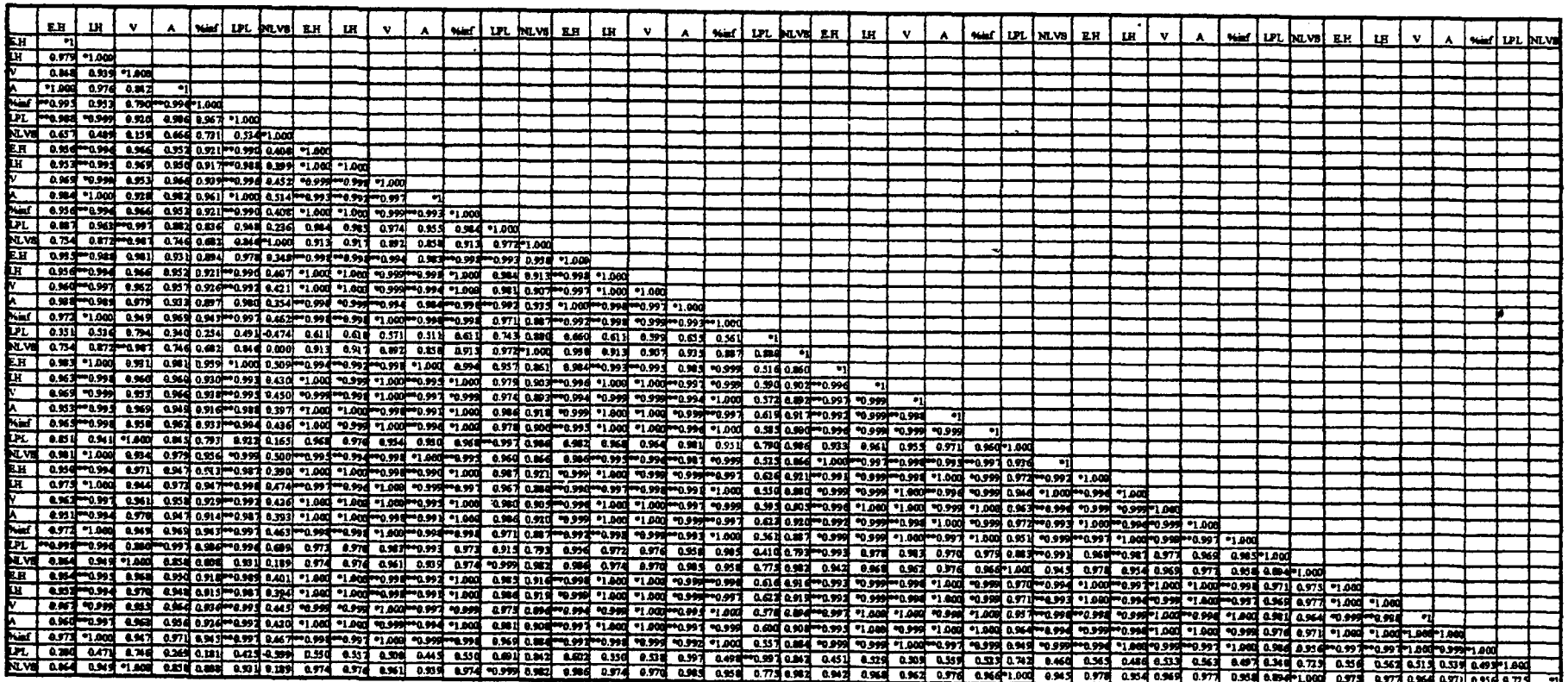
*,** :- Significant at 1 % and 5 % respectively.

Table- 64: - Correlation co-efficient (r) values among various infection levels and growth of crop plants from 30-180 days net house experiment in maize crops (pure) in jhum land soil

	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS
E.H	*1																																										
LH	0.881	*1.000																																									
V	0.910	**0.998	*1.000																																							
A	0.973	0.965	0.980	*1.000																																						
%inf	**0.987	0.946	0.965	**0.998	*1.000																																					
LPL	**0.997	0.845	0.878	0.956	0.973	*1.000																																			
NLVS	*0.999	0.903	0.929	0.984	**0.994	**0.993	*1																																		
E.H	0.984	0.952	0.970	*0.999	*1.000	0.968	**0.991	*1.000																																		
LH	**0.992	0.934	0.956	**0.995	*0.999	0.980	**0.997	*0.999	*1																																
V	**0.990	0.939	0.960	**0.997	*1.000	0.977	**0.996	*0.999	*1.000	*1.000																																
A	0.980	0.958	0.975	*1.000	*0.999	0.963	**0.988	*1.000	**0.997	**0.998	*1.000																																
%inf	**0.998	0.910	0.935	**0.987	**0.995	**0.991	*1.000	**0.993	**0.998	**0.997	**0.990	*1.000																														
LPL	0.926	0.994	*0.999	**0.987	0.975	0.897	0.943	0.979	0.967	0.970	0.983	0.949	*1.000																													
NLVS	*0.999	0.903	0.929	0.984	**0.994	**0.993	*1.000	**0.991	**0.997	**0.996	**0.988	*1.000	0.943	*1.000																												
E.H	**0.995	0.923	0.946	**0.992	**0.998	0.986	*0.999	**0.996	*1.000	*0.999	**0.994	*0.999	0.959	*0.999	*1.000																											
LH	*1.000	0.893	0.920	0.980	**0.991	**0.995	*1.000	**0.998	**0.995	**0.993	0.984	*0.999	0.935	*1.000	**0.997	*1.000																										
V	0.982	0.955	0.973	*0.999	*1.000	0.965	**0.990	*1.000	**0.998	*0.999	*1.000	**0.992	0.981	**0.990	**0.996	0.986	*1.000																									
A	**0.991	0.938	0.958	**0.996	*1.000	0.978	**0.996	*0.999	*1.000	*1.000	**0.998	**0.997	0.989	**0.996	*0.999	**0.994	**0.998	*1																								
%inf	**0.996	0.922	0.945	**0.991	**0.998	0.986	*0.999	**0.996	*0.999	*0.999	**0.994	*1.000	0.958	*0.999	*1.000	**0.998	**0.995	*0.999	*1.000																							
LPL	0.952	0.983	**0.993	**0.996	**0.989	0.928	0.966	**0.992	0.983	0.986	**0.994	0.970	**0.997	0.966	0.977	0.960	**0.993	0.985	0.977	*1.000																					
NLVS	0.958	0.980	**0.991	**0.998	**0.992	0.935	0.971	**0.994	**0.987	**0.989	**0.996	0.974	**0.995	0.971	0.981	0.965	**0.995	**0.988	0.981	*1.000	*1.000																			
E.H	**0.994	0.928	0.950	**0.993	*0.999	0.983	**0.998	**0.997	*1.000	*0.999	**0.996	*0.999	0.962	**0.998	*1.000	**0.996	**0.997	*1.000	*1.000	0.980	0.984	*1.000																			
LH	**0.993	0.931	0.953	**0.994	*0.999	0.982	**0.997	**0.998	*1.000	*1.000	**0.997	**0.998	0.963	**0.997	*1.000	**0.996	**0.997	*1.000	*1.000	0.982	0.985	*1.000	*1.000																		
V	0.982	0.954	0.972	*0.999	*1.000	0.966	**0.990	*1.000	**0.998	*0.999	*1.000	**0.992	0.981	**0.990	**0.996	**0.987	*1.000	*0.999	**0.996	**0.993	**0.995	**0.997	**0.998	*1.000																	
A	0.985	0.950	0.968	*0.999	*1.000	0.970	**0.992	*1.000	*0.999	*1.000	**0.994	0.978	**0.992	**0.997	**0.985	*1.000	*0.999	**0.997	**0.991	**0.993	**0.998	*0.999	*1.000	*1.000																	
%inf	**0.998	0.909	0.934	**0.987	**0.995	**0.991	*1.000	**0.998	**0.998	**0.997	**0.990	*1.000	0.948	*1.000	*0.999	*0.999	**0.992	**0.997	*0.999	0.969	0.974	*0.999	**0.998	**0.992	**0.994	*1.000															
LPL	0.930	0.993	*0.999	**0.985	0.977	0.901	0.946	0.981	0.969	0.973	0.985	0.952	*1.000	0.946	0.961	0.939	0.983	0.971	0.960	**0.998	**0.996	0.965	0.967	0.982	0.979	0.951	*1														
NLVS	0.928	**0.994	*0.999	**0.988	0.976	0.899	0.945	0.980	0.968	0.972	0.984	0.950	*1.000	0.945	0.960	0.937	0.982	0.970	0.959	**0.997	**0.996	0.963	0.966	0.981	0.978	0.949	*1.000	*1.000												
E.H	**0.997	0.915	0.940	**0.989	**0.996	**0.989	*1.000	**0.995	*0.999	**0.998	**0.992	*1.000	0.953	*1.000	*1.000	*0.999	**0.993	**0.998	*1.000	0.973	0.977	*0.999	*0.999	**0.994	**0.995	*1.000	0.956	0.954	*1.000											
LH	0.912	0.610	0.660	0.797	0.834	0.939	0.891	0.823	0.852	0.864	0.811	0.884	0.690	0.891	0.868	0.901	0.817	0.847	0.869	0.743	0.756	0.861	0.856	0.819	0.827	0.883	0.697	0.693	0.877	*1.000										
V	*0.999	0.856	0.888	0.962	0.977	*1.000	**0.995	0.973	0.984	0.981	0.968	**0.993	0.906	**0.995	**0.989	**0.997	0.971	0.982	**0.989	0.935	0.942	**0.987	0.985	0.971	0.975	**0.994	0.910	0.908	**0.992	0.932	*1.000									
A	**0.991	0.936	0.957	**0.996	*1.000	0.975	**0.997	*0.999	*1.000	*1.000	**0.997	**0.998	0.968	**0.997	*0.999	**0.994	**0.998	*1.000	*0.999	0.984	0.987	*1.000	*1.000	**0.998	*0.999	**0.998	0.970	0.969	*0.999	0.850	0.983	*1.000								
%inf	*0.999	0.905	0.931	0.985	**0.994	**0.992	*1.000	**0.992	**0.997	**0.996	**0.989	*1.000	0.945	*1.000	*0.999	*1.000	**0.990	**0.996	*0.999	0.967	0.972	**0.998	**0.998	**0.991	**0.993	*1.000	0.948	0.946	*1.000	0.889	0.995	**0.997	*1.000							
LPL	0.924	**0.995	*0.999	0.986	0.974	0.894	0.942	0.978	0.965	0.969	0.982	0.947	*1.000	0.942	0.957	0.933	0.980	0.968	0.956	**0.997	**0.995	0.961	0.963	0.979	0.976	0.946	*1.000	*1.000	0.951	0.686	0.903	0.966	0.943	*1						
NLVS	0.928	**0.994	*0.999	**0.988	0.976	0.899	0.945	0.980	0.968	0.972	0.984	0.950	*1.000	0.945	0.960	0.937	0.982	0.970	0.959	**0.997	**0.996	0.963	0.966	0.981	0.978	0.949	*1.000	*1.000	0.954	0.693	0.908	0.969	0.946	*1.000	*1.000					
E.H	**0.998	0.910	0.936	**0.987	**0.995	**0.990	*1.000	**0.993	**0.998	**0.997	**0.991	*1.000	0.949	*1.000	*1.000	*0.999	**0.992	**0.997	*1.000	0.970	0.975	*0.999	*0.999	**0.992	**0.996	*1.000	0.952	0.951	*1.000	0.883	0.993	**0.998	1.000	0.947	0.951	*1.000				
LH	**0.992	0.931	0.953	**0.994	*0.999	0.982	**0.997	**0.998	*1.000	*1.000	**0.997	**0.998	0.965	**0.997	*1.000	**0.996	**0.997	*1.000	*1.000	0.982	0.985	*1.000	*1.000	**0.998	*0.999	**0.998	0.967	0.966	*0.999	0.856	0.985	*1.000	**0.998	0.963	0.966	*0.999	*1.000			
V	**0.991	0.938	0.958	**0.996	*1.000	0.978	**0.996	*0.999	*1.000	*1.000	**0.998	**0.997	0.969	**0.996	*0.999	**0.994	**0.998	*1.000	*0.999	0.985	**0.988	*1.000	*1.000	*0.999	*0.999	**0.997	0.971	0.970	**0.998	0.847	0.982	*1.000	**0.996	0.968	0.970	**0.997	*1.000	*1.000		
A	**0.988	0.941	0.961	**0.997	*1.000	0.976	**0.995	*0.999	*1.000	*1.000	**0.998	**0.997	0.972	**0.993	*0.999	**0.993	**0.998	*1.000	*0.999	0.985	**0.988	*1.000	*1.000	*0.999	*0.999	**0.997	0.971	0.970	**0.998	0.847	0.982	*1.000	**0.996	0.968	0.970	**0.997	*1.000	*1.000		
%inf	**0.997	0.914	0.939	**0.989	**0.996	**0.988	*1.000	**0.994	*0.999	**0.998	**0.992	*1.000	0.952	*1.000	*1.000	*0.999	**0.993	**0.998	*1.000	0.972	0.977	*0.999	*0.999	**0.994	**0.995	*1.000	0.955	0.953	*1.000	0.878	**0.992	**0.998	*1.000	0.950	0.953	*1.000	*0.999	**0.998	**0.997	*1.000	
LPL	0.918	**0.996	*1.000	0.984	0.970	0.887	0.936	0.975	0.961	0.965	0.979	0.942	*1.000	0.936	0.952	0.928	0.977	0.964	0.951	**0.995	**0.993	0.956	0.959	0.976	0.573	0.941	*1.000	*1.000	0.946	0.675	0.897	0.962	0.937	*1.000	*1.000	0.942	0.959	0.964	0.966	0.945	*1.000	
NLVS	0.928	**0.994	*0.999	**0.988	0.976	0.899	0.945	0.980	0.968	0.972	0.984	0.950	*1.000	0.945	0.960	0.937	0.982	0.970	0.959	**0.997	**0.996	0.963	0.966	0.981	0.978	0.949	*1.000	*1.000	0.954	0.693	0.908	0.969	0.946	*1.000	*1.000	0.951	0.966	0.970	0.973	0.953	*1.000	*1

*,** :- Significant at 1 % and 5 % respectively.

Table-65: - Correlation co-efficient (r) values among various infection levels and growth of crop plants from 30-180 days net house experiment in paddy crops (pure) in jhum land soil



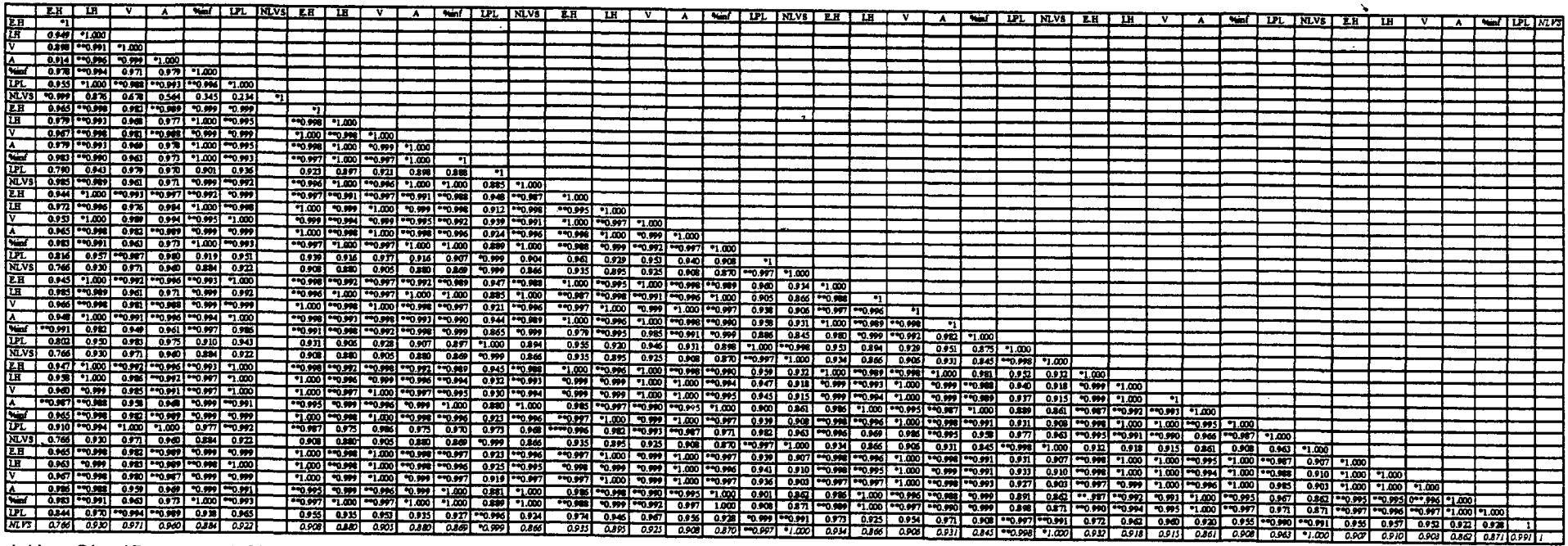
*,** :- Significant at 1 % and 5 % respectively.

Table-66: - Correlation co-efficient (r) values among various infection levels and growth of crop plants from 30-180 days net house experiment in potato crops (pure) in jhum land soil

	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS
E.H	*1																																										
LH	**0.997	*1.000																																									
V	**0.989	**0.997	*1.000																																							
A	**0.996	0.986	0.971	*1.000																																						
%inf	**0.993	0.982	0.965	*1.000	*1																																					
LPL	**0.987	**0.994	1.000	0.968	0.961	*1.000																																			
NLVS	0.983	0.970	0.949	**0.997	*0.999	0.945	*1.000																																			
E.H	**0.997	**0.988	0.973	*1.000	*0.999	0.970	**0.996	*1.000																																		
LH	**0.998	*1.000	**0.996	*0.988	0.984	**0.995	0.974	**0.990	*1.000																																	
V	**0.993	*1.000	*0.999	0.982	0.977	**0.998	0.965	0.984	*0.999	*1																																
A	*0.999	**0.993	0.981	*0.999	**0.997	0.979	**0.992	*0.999	**0.995	**0.990	*1.000																															
%inf	**0.996	0.986	0.971	*1.000	*1.000	0.967	**0.997	*1.000	**0.988	0.982	*0.999	*1.000																														
LPL	0.988	0.961	0.979	0.903	0.891	0.982	0.866	0.907	0.957	0.967	0.922	0.902	*1.000																													
NLVS	0.983	0.970	0.949	**0.997	*0.999	0.945	*1.000	**0.996	0.974	0.965	**0.992	**0.997	0.866	*1.000																													
E.H	0.986	0.971	0.950	**0.997	*0.999	0.945	*1.000	**0.996	0.974	0.963	**0.992	*0.997	0.867	*1.000	*1.000																												
LH	**0.998	**0.991	0.978	*1.000	**0.998	0.975	**0.994	*1.000	**0.993	**0.988	*1.000	*0.999	0.916	**0.994	**0.994	*1.000																											
V	**0.998	**0.990	0.976	*1.000	*0.999	0.973	**0.995	*1.000	**0.992	0.986	*1.000	*1.000	0.912	**0.995	**0.995	*1.000	*1.000																										
A	**0.994	0.984	0.967	*1.000	*1.000	0.964	**0.998	*1.000	0.986	0.979	**0.998	*1.000	0.896	**0.998	**0.998	*0.999	*0.999	*1.000																									
%inf	**0.996	**0.987	0.973	*1.000	*0.999	0.970	**0.994	*1.000	**0.990	0.984	*0.999	*1.000	0.906	**0.996	**0.996	*1.000	*1.000	*1.000	*1																								
LPL	0.979	0.962	0.939	**0.994	**0.996	0.934	*0.999	**0.993	0.966	0.956	**0.987	**0.994	0.849	*0.999	*0.999	**0.990	**0.991	**0.995	**0.993	*1.000																						
NLVS	0.985	0.970	0.949	**0.997	*0.999	0.945	*1.000	**0.996	0.974	0.965	**0.992	**0.997	0.866	*1.000	*1.000	**0.994	**0.995	**0.998	**0.996	*0.999	*1																					
E.H	*0.999	**0.994	0.983	*0.999	**0.997	0.980	**0.991	*0.999	0.995	0.991	*1.000	**0.998	0.924	**0.991	**0.991	*1.000	*1.000	**0.998	*0.999	0.986	**0.991	*1.000																				
LH	**0.995	0.985	0.969	*1.000	*1.000	0.965	**0.998	*1.000	0.987	0.981	**0.998	*1.000	0.899	**0.998	**0.998	*0.999	*0.999	*1.000	*1.000	**0.995	**0.998	**0.998	*1.000																			
V	**0.993	0.981	0.963	*1.000	*1.000	0.960	*0.999	*0.999	0.983	0.976	**0.997	*1.000	0.889	*0.999	*0.999	**0.998	*0.999	*1.000	*0.999	**0.997	*0.999	**0.996	*1.000	*1																		
A	*1.000	**0.996	0.987	**0.997	**0.995	0.984	**0.988	**0.998	0.997	0.994	*1.000	**0.997	0.933	**0.988	**0.988	*0.999	**0.998	**0.996	**0.998	0.982	**0.988	*1.000	**0.996	**0.994	**1.000																	
%inf	**0.995	0.985	0.969	*1.000	*1.000	0.965	**0.998	*1.000	0.987	0.981	**0.998	*1.000	0.899	**0.998	**0.998	*0.999	*0.999	*1.000	*1.000	**0.995	**0.998	**0.998	*1.000	*1.000	**0.996	*1.000																
LPL	0.640	0.695	0.747	0.566	0.545	0.756	0.300	0.574	0.685	0.710	0.606	0.565	0.866	0.300	0.302	0.592	0.585	0.554	0.573	0.471	0.500	0.610	0.559	0.541	0.629	0.559	*1.000															
NLVS	0.856	0.892	0.923	0.803	0.790	0.929	0.736	0.811	0.885	0.902	0.833	0.804	0.982	0.736	0.757	0.823	0.818	0.796	0.810	0.734	0.756	0.836	0.800	0.787	0.869	0.800	0.945	*1.000													
E.H	0.986	0.972	0.951	**0.997	*0.999	0.947	*1.000	**0.997	0.975	0.966	**0.993	**0.998	0.869	*1.000	*1.000	**0.995	**0.995	**0.998	**0.997	*0.999	*1.000	**0.997	**0.998	*0.999	**0.989	**0.998	0.903	0.760	*1.000												
LH	**0.996	**0.987	0.972	*1.000	*1.000	0.969	**0.997	*1.000	**0.989	0.983	*0.999	*1.000	0.904	**0.997	**0.997	*1.000	*1.000	*1.000	*1.000	**0.993	**0.997	*0.999	*1.000	*0.999	**0.997	*1.000	0.570	0.807	**0.997	*1.000											
V	0.985	0.970	0.948	**0.997	**0.998	0.944	*1.000	**0.996	0.973	0.964	**0.992	**0.997	0.865	*1.000	*1.000	**0.994	**0.995	**0.998	**0.996	*1.000	*1.000	**0.997	*0.999	**0.987	**0.997	0.498	0.734	*1.000	**0.996	*1.000										
A	0.986	0.971	0.950	**0.997	*0.999	0.946	*1.000	**0.996	0.974	0.966	**0.992	**0.997	0.868	*1.000	*1.000	**0.994	**0.995	**0.998	**0.997	*0.999	*1.000	**0.997	*0.999	**0.988	*0.998	0.503	0.758	*1.000	**0.997	*1.000	*1.000									
%inf	**0.991	0.979	0.961	*0.999	*1.000	0.957	*0.999	*0.999	0.982	0.974	**0.996	*0.999	0.883	*0.999	*0.998	**0.998	**0.998	*1.000	*0.999	**0.997	*0.999	**0.996	*1.000	*1.000	**0.993	*1.000	0.534	0.781	*0.999	*0.999	*0.999	*0.999	*1							
LPL	**0.989	0.975	0.955	**0.998	*0.999	0.951	*1.000	**0.998	0.978	0.970	**0.994	**0.998	0.876	*1.000	*1.000	**0.996	**0.997	*0.999	**0.998	*0.999	*1.000	**0.994	*0.999	*1.000	**0.991	*0.999	0.517	0.769	*1.000	**0.998	*1.000	*1.000	*1.000	*1						
NLVS	0.985	0.970	0.949	**0.997	*0.999	0.945	*1.000	**0.996	0.974	0.965	**0.992	**0.997	0.866	*1.000	*1.000	**0.994	**0.995	**0.998	**0.996	*0.999	*1.000	**0.998	*0.999	**0.988	**0.998	0.500	0.756	*1.000	**0.997	*1.000	*1.000	*0.999	*1.000	*1.000					
E.H	**0.991	0.979	0.961	*0.999	*1.000	0.957	*0.999	*0.999	0.982	0.974	**0.996	*0.999	0.884	*0.999	*0.999	**0.997	**0.998	*1.000	*0.999	**0.997	*0.999	**0.998	*1.000	*1.000	**0.994	**0.999	0.533	0.780	*0.999	*0.999	*0.999	*0.999	*1.000	*1.000	*0.999	*1.000				
LH	**0.998	**0.990	0.977	*1.000	*0.999	0.974	**0.995	*1.000	0.992	0.987	*1.000	*1.000	0.913	**0.995	**0.995	*1.000	*1.000	*0.999	*1.000	**0.991	**0.995	*1.000	*0.999	**0.998	*0.999	*0.999	0.587	0.819	**0.995	*1.000	**0.994	**0.995	**0.998	**0.996	**0.995	**0.998	*1.000			
V	0.969	0.948	0.921	**0.987	**0.991	0.916	**0.997	0.986	0.952	0.940	0.979	**0.988	0.823	**0.997	**0.997	0.982	0.983	**0.990	0.986	*0.999	**0.997	0.977	**0.989	**0.992	0.972	**0.989	0.429	0.701	**0.996	**0.987	**0.997	**0.996	**0.993	**0.995	**0.997	**0.993	0.983	*1.000		
A	0.979	0.962	0.938	**0.994	**0.996	0.933	*0.999	**0.993	0.965	0.955	**0.987	**0.994	0.849	*0.999	*0.999	**0.990	**0.991	**0.995	**0.993	*1.000	*0.999	0.986	**0.995	**0.997	0.982	**0.995	0.470	0.733	*0.999	**0.993	*1.000	*0.999	**0.997	*0.999	**0.997	**0.991	*0.999	*1.000		
%inf	0.995	0.984	0.968	*1.000	*1.000	0.965	**0.998	*1.000	0.987	0.980	**0.998	*1.000	0.897	**0.998	**0.998	*0.999	**0.999	*1.000	*1.000	**0.995	**0.998	**0.998	*1.000	*1.000	**0.996	*1.000	0.557	0.798	**0.998	*1.000	**0.998	**0.998	*1.000	*0.999	**0.998	*1.000	*0.999	**0.989	**0.995	*1.000	
LPL	0.768	0.719	0.665	0.824	0.838	0.655	0.866	0.819	0.729	0.704	0.796	0.825	0.900	0.866	0.865	0.806	0.811	0.833	0.820	0.882	0.866	0.792	0.829	0.841	0.777	0.829	0.000	0.327	0.863	0.822	0.867	0.864	0.845	0.856	0.866	0.846	0.810	0.903	0.882	0.883	*1.000	
NLVS	0.985	0.970	0.949	**0.997	*0.999	0.945	*1.000	**0.996	0.974	0.965	**0.992	**0.997	0.866	*1.000	*1.000	**0.994	**0.995	**0.998	**0.996	*0.999	*1.000	**0.991	**0.998	*0.999	**0.988	**0.998	0.500	0.756	*1.000	**0.997	*1.000	*1.000	**0.999	*1.000	*1.000	**0.999	**0.995	**0.997	**0.999	**0.998	0.866	*1

*,** :- Significant at 1 % and 5 % respectively.

Table-67: - Correlation co-efficient (r) values among various infection levels and growth of crop plants from 30-180 days net house experiment in maize crops (mixed) in valley land soil



*,** :- Significant at 1 % and 5 % respectively.

Table-68: - Correlation co-efficient (r) values among various infection levels and growth of crop plants from 30-180 days net house experiment in paddy crops(mixed) in valley land soil

	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS
E.H	*1																																		
LH	**0.997	*1.000																																	
V	*1.000	**0.998	*1.000																																
A	*0.999	*0.999	*1.000	*1.000																															
%inf	**0.997	*1.000	**0.997	*0.999	*1.000																														
LPL	**0.994	*1.000	**0.995	**0.998	*1.000	*1.000																													
NLVS	**0.993	*0.999	**0.994	**0.996	*0.999	*1.000	*1.000																												
E.H	*1.000	**0.995	*1.000	**0.998	**0.995	**0.992	**0.990	*1.000																											
LH	**0.996	*1.000	**0.997	*0.999	*1.000	*1.000	**0.999	**0.995	*1.000																										
V	**0.995	*1.000	**0.996	**0.998	*1.000	*1.000	*1.000	**0.993	*1.000	*1.000																									
A	**0.993	*1.000	**0.996	**0.998	*1.000	*1.000	*1.000	**0.993	*1.000	*1.000	*1																								
%inf	**0.996	*1.000	**0.996	**0.998	*1.000	*1.000	*1.000	**0.996	*1.000	*1.000	*1.000	*1.000																							
LPL	0.986	0.970	0.985	0.979	0.969	0.963	0.958	**0.989	0.968	0.965	0.965	0.966	*1.000																						
NLVS	0.602	0.537	0.595	0.571	0.536	0.514	0.500	0.617	0.532	0.520	0.522	0.524	0.727	*1.000																					
E.H	*1.000	**0.996	*1.000	**0.999	**0.996	**0.993	**0.991	*1.000	**0.995	**0.994	**0.994	*0.995	**0.988	0.610	*1.000																				
LH	*0.999	*0.999	*1.000	*1.000	*0.999	**0.998	**0.997	**0.998	*0.999	**0.998	**0.998	*0.999	0.979	0.570	*0.999	*1.000																			
V	**0.993	*0.999	**0.994	**0.997	*0.999	*1.000	*1.000	**0.990	*0.999	*1.000	*1.000	*1.000	0.959	0.502	**0.992	**0.997	*1.000																		
A	**0.997	*1.000	**0.998	*0.999	*1.000	*0.999	*0.999	**0.996	*1.000	*1.000	*1.000	*1.000	0.971	0.543	**0.997	*0.999	*0.999	*1.000																	
%inf	**0.998	*1.000	**0.998	*1.000	*1.000	**0.999	**0.998	**0.996	*1.000	*0.999	*1.000	*1.000	0.973	0.549	**0.997	*1.000	*0.999	*1.000	*1.000																
LPL	**0.997	**0.988	**0.996	**0.993	**0.988	0.983	0.980	**0.998	**0.987	0.983	0.985	0.986	**0.996	0.661	**0.998	**0.993	0.981	**0.989	**0.990	*1															
NLVS																			**	*1	*1														
E.H	**0.998	**0.990	**0.998	**0.995	**0.990	0.986	0.983	*0.999	**0.989	**0.987	**0.988	**0.988	**0.994	0.649	*0.999	**0.995	0.984	**0.991	**0.992	*1.000		*1													
LH	*1.000	**0.995	*1.000	**0.998	**0.995	**0.992	**0.990	*1.000	**0.995	**0.993	**0.993	**0.994	**0.989	0.617	*1.000	**0.998	**0.990	**0.996	**0.996	**0.998		*0.999	*1.000												
V	**0.991	**0.998	**0.992	**0.995	*0.999	*1.000	*1.000	**0.988	*0.999	*0.999	*0.999	*0.999	0.955	0.490	**0.990	**0.996	*1.000	**0.998	*0.998	0.978		0.981	**0.988	*1.000											
A	**0.997	*1.000	**0.997	*0.999	*1.000	*1.000	*0.999	**0.995	*1.000	*1.000	*1.000	*1.000	0.969	0.535	**0.996	*0.999	*0.999	*1.000	*1.000	**0.988		**0.990	**0.995	*0.999	*1.000									
%inf	*0.999	*0.999	*1.000	*1.000	**0.999	**0.998	**0.996	*0.999	*0.999	**0.998	**0.998	**0.998	0.979	0.573	*0.999	*1.000	**0.996	*0.999	*1.000	**0.994		**0.993	*0.999	**0.995	*0.999	*1.000								
LPL	0.845	0.800	0.840	0.824	0.799	0.783	0.773	0.855	0.796	0.788	0.789	0.791	0.922	0.936	0.850	0.823	0.775	0.80-	0.808	0.883		0.875	0.855	0.766	0.798	0.825	*1							
NLVS	0.390	0.462	0.398	0.425	0.464	0.486	0.500	0.373	0.468	0.479	0.477	0.475	0.231	-0.500	0.382	0.427	0.498	0.456	0.450	0.319		0.334	0.373	0.510	0.464	0.423	-0.163	*1.000						
E.H	*1.000	**0.994	*0.999	**0.998	**0.994	**0.991	**0.989	*1.000	**0.993	**0.992	**0.992	**0.992	**0.990	0.625	*1.000	**0.993	*0.989	**0.995	**0.996	*0.999		*1.000	*1.000	**0.987	**0.994	*0.998	0.860	0.364	*1.000					
LH	*1.000	**0.994	*0.999	**0.998	**0.994	**0.991	**0.989	*1.000	**0.993	**0.992	**0.992	**0.992	**0.990	0.625	*1.000	**0.998	**0.989	**0.995	**0.996	*0.999		*1.000	*1.000	**0.987	**0.994	**0.998	0.860	0.364	*1.000	*1.000				
V	**0.990	**0.998	**0.991	**0.995	**0.998	*0.999	*1.000	**0.987	**0.998	*0.999	*0.999	*0.999	0.952	0.482	**0.988	**0.995	*1.000	**0.998	**0.997	0.976		0.979	**0.987	*1.000	**0.998	**0.994	0.760	0.517	0.985	0.985	*1.000			
A	*0.999	*1.000	*0.999	*1.000	*1.000	*0.999	**0.998	**0.997	*1.000	*0.999	*0.999	*0.999	0.976	0.358	**0.998	*1.000	**0.998	*1.000	*1.000	**0.992		**0.994	**0.997	**0.997	*1.000	*1.000	0.815	0.439	**0.997	**0.997	**0.996	*1.000		
%inf	**0.998	*1.000	*0.999	*1.000	*1.000	**0.999	**0.998	**0.997	*1.000	*0.999	*0.999	*0.999	0.975	0.355	**0.998	*1.000	**0.998	*1.000	*1.000	**0.991		**0.993	**0.997	**0.997	*1.000	*1.000	0.813	0.443	**0.996	**0.996	**0.996	*1.000	*1.000		
LPL	**0.993	*0.999	**0.994	**0.996	*0.999	*1.000	*1.000	**0.990	*0.999	*1.000	*1.000	*1.000	0.958	0.500	**0.991	**0.997	*1.000	*0.999	**0.998	0.980		0.983	**0.990	*1.000	*0.999	**0.996	0.773	0.500	**0.989	**0.989	*1.000	**0.998	**0.998	*1	
NLVS	0.390	0.462	0.398	0.425	0.464	0.486	0.500	0.373	0.468	0.479	0.477	0.475	0.231	-0.300	0.382	0.427	0.498	0.456	0.450	0.319		0.334	0.373	0.510	0.464	0.423	-0.163	*1.000	0.364	0.364	0.517	0.439	0.443	0.5	*1
E.H	**0.998	**0.991	**0.998	**0.995	**0.990	0.986	0.984	*0.999	**0.990	**0.988	**0.988	**0.988	**0.994	0.648	*0.999	**0.995	0.984	**0.991	**0.992	*1.000		*1.000	*0.999	0.982	**0.990	**0.996	0.875	0.336	*1.000	*1.000	0.980	**0.994	**0.993	0.984	0.336	*1.000
LH	*1.000	**0.995	*1.000	**0.998	**0.995	**0.992	**0.990	*1.000	**0.995	**0.993	**0.993	**0.994	**0.989	0.617	*1.000	**0.998	**0.990	**0.996	**0.996	**0.998		*0.999	*1.000	**0.988	**0.995	*0.999	0.853	0.373	*1.000	*1.000	**0.987	**0.997	**0.997	**0.996	0.373	*0.999	*1.000
V	**0.987	**0.996	**0.988	**0.992	**0.997	**0.998	*0.999	0.983	**0.997	**0.998	**0.998	**0.998	0.945	0.463	0.985	**0.992	*0.999	**0.996	**0.995	0.971		0.975	0.983	*1.000	**0.997	**0.992	0.746	0.536	0.981	0.981	*1.000	**0.994	**0.994	*0.999	0.536	0.975	0.983	*1.000
A	*0.999	*0.999	*1.000	*1.000	*0.999	**0.997	**0.996	*0.999	*0.999	**0.998	*0.998	**0.998	0.980	0.574	*0.999	*1.000	**0.996	*0.999	*1.000	**0.994		**0.996	*0.999	**0.995	*0.999	*1.000	0.826	0.422	*0.998	**0.998	**0.994	*1.000	*1.000	**0.996	0.422	**0.998	*0.999	**0.992	*1.000
%inf	**0.998	*1.000	**0.998	*1.000	*1.000	*0.999	*0.999	**0.996	*1.000	*1.000	*1.000	*1.000	0.972	0.546	**0.997	*1.000	*0.999	*1.000	*1.000	**0.989		**0.992	**0.996	**0.998	*1.000	*0.999	0.806	0.453	**0.995	**0.995	**0.997	*1.000	*1.000	*0.999	0.453	**0.992	**0.996	**0.995	*0.999	*1.000
LPL	**0.993	*0.999	**0.994	**0.996	*0.999	*1.000	*1.000	**0.990	*0.999	*1.000	*1.000	*1.000	0.958	0.500	**0.991	**0.997	*1.000	*0.999	**0.998	0.980		0.983	**0.990	*1.000	*0.999	**0.996	0.773	0.500	**0.989	**0.989	*1.000	**0.998	**0.998	*1.000	0.500	0.984	**0.996	*0.999	**0.996	*0.999	*1	
NLVS	0.390	0.462	0.398	0.425	0.464	0.486	0.500	0.373	0.468	0.479	0.477	0.475	0.231	-0.500	0.382	0.427	0.498	0.456	0.450	0.319		0.334	0.373	0.510	0.464	0.423	-0.163	*1.000	0.364	0.364	0.517	0.439	0.443	0.500	*1.000	0.336	0.373	0.536	0.422	0.453	0.5	*1

*,** :- Significant at 1 % and 5 % respectively.

Table-69: - Correlation co-efficient (r) values among various infection levels and growth of crop plants from 30-180 days net house experiment in potato crops (mixed) in valley land soil

	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS
E.H	*1																											
LH	*1	*1																										
V	*1	0.932	*1.000																									
A	*1	**0.994	0.978	*1.000																								
%inf	*1	**0.996	0.922	0.982	*1.000																							
LPL	*1	0.969	**0.998	**0.989	0.944	1.000																						
NLVS	*1	0.928	**0.995	0.955	0.883	0.988	*1																					
E.H	*1	*1	*1	*1	*1	*1	*1	*1																				
LH	*1	*0.999	0.966	*0.999	**0.991	0.980	0.939	*1	*1																			
V	*1	**0.998	0.969	*0.999	**0.990	0.982	0.942	*1	*1.000	*1.000																		
A	-1	0.493	0.204	0.403	0.566	0.264	0.114	-1	0.445	0.441	*1																	
%inf	*1	*0.999	0.935	0.988	*0.999	0.955	0.898	*1	**0.995	**0.994	0.539	*1.000																
LPL	*1	**0.997	0.928	0.985	*1.000	0.965	0.890	*1	**0.993	**0.991	0.553	*1.000	*1.000															
NLVS	*1	0.921	**0.996	0.955	0.884	**0.988	*1.000	*1	0.939	0.942	0.114	0.896	0.890	*1.000														
E.H	*1	*1.000	0.953	**0.995	**0.996	0.970	0.927	*1	*0.999	**0.998	0.492	**0.998	**0.997	0.921	*1.000													
LH	*1	*1.000	0.944	**0.992	**0.998	0.962	0.910	*1	**0.997	**0.996	0.516	*1.000	*0.999	0.910	*1.000	*1.000												
V	*1	**0.998	0.968	*0.999	**0.990	0.982	0.941	*1	*1.000	*1.000	0.442	**0.994	**0.992	0.941	**0.996	**0.996	*1.000											
A	*1	*0.999	0.942	**0.991	*0.999	0.961	0.908	*1	**0.997	**0.996	0.520	*1.000	*0.99	0.908	*0.999	*1.000	**0.996	*1.000										
%inf	*1	**0.997	0.928	0.985	*1.000	0.949	0.889	*1	**0.993	**0.991	0.525	*1.000	*1.00	0.889	**0.997	*0.997	**0.991	*0.999	*1.000									
LPL	*1	**0.993	0.982	*1.000	0.979	**0.992	0.961	*1	**0.998	**0.996	0.383	0.985	0.961	0.961	**0.993	**0.989	**0.998	**0.988	0.981	*1								
NLVS	*1	**0.993	0.908	0.975	*0.999	0.932	0.866	*1	0.985	0.984	0.595	**0.998	*0.999	0.866	**0.992	**0.985	0.984	**0.996	*0.999	0.971	*1.000							
E.H	*1	*1.000	0.955	**0.996	**0.996	0.971	0.924	*1	*0.999	*0.999	0.486	**0.998	**0.997	0.924	*1.000	**0.999	*0.999	**0.999	**0.997	**0.994	**0.992	*1.000						
LH	*1	*0.999	0.964	**0.998	**0.992	0.978	0.935	*1	*1.000	*1.000	0.458	**0.996	**0.994	0.935	*0.999	**0.998	*1.000	**0.997	**0.994	**0.997	**0.987	*1.000	*1.000					
V	*1	*1.000	0.956	**0.996	**0.995	0.972	0.925	*1	*0.999	*0.999	0.483	**0.998	**0.996	0.925	*1.000	*0.999	*0.999	*0.999	**0.996	**0.994	**0.991	*1.000	*1.000	*1.000				
A	*1	*0.999	0.964	**0.998	**0.992	0.979	0.936	*1	*1.000	*1.000	0.457	**0.995	**0.993	0.936	*0.999	**0.998	*1.000	**0.997	**0.993	**0.997	**0.987	*0.999	*1.000	*1.000	*1.000			
%inf	*1	**0.997	0.929	0.985	*1.000	0.949	0.891	*1	**0.993	**0.992	0.553	*1.000	1.000	0.891	**0.997	*0.999	**0.992	*0.999	*1.000	0.962	*0.999	**0.997	**0.994	**0.997	**0.994	*1.000		
LPL	*1	**0.995	0.979	*1.000	0.982	0.990	0.956	*1	*0.999	*0.999	0.400	**0.988	0.984	0.956	**0.995	**0.982	*0.999	**0.991	0.984	*1.000	0.975	**0.995	*0.998	**0.996	**0.998	0.985	*1.000	
NLVS	*1	**0.993	0.908	0.975	*0.999	0.932	0.866	*1	0.985	0.984	0.595	**0.998	0.999	0.866	**0.992	**0.995	0.984	**0.996	*0.999	0.971	*1.000	**0.992	**0.987	**0.991	**0.987	*0.999	0.975	*1

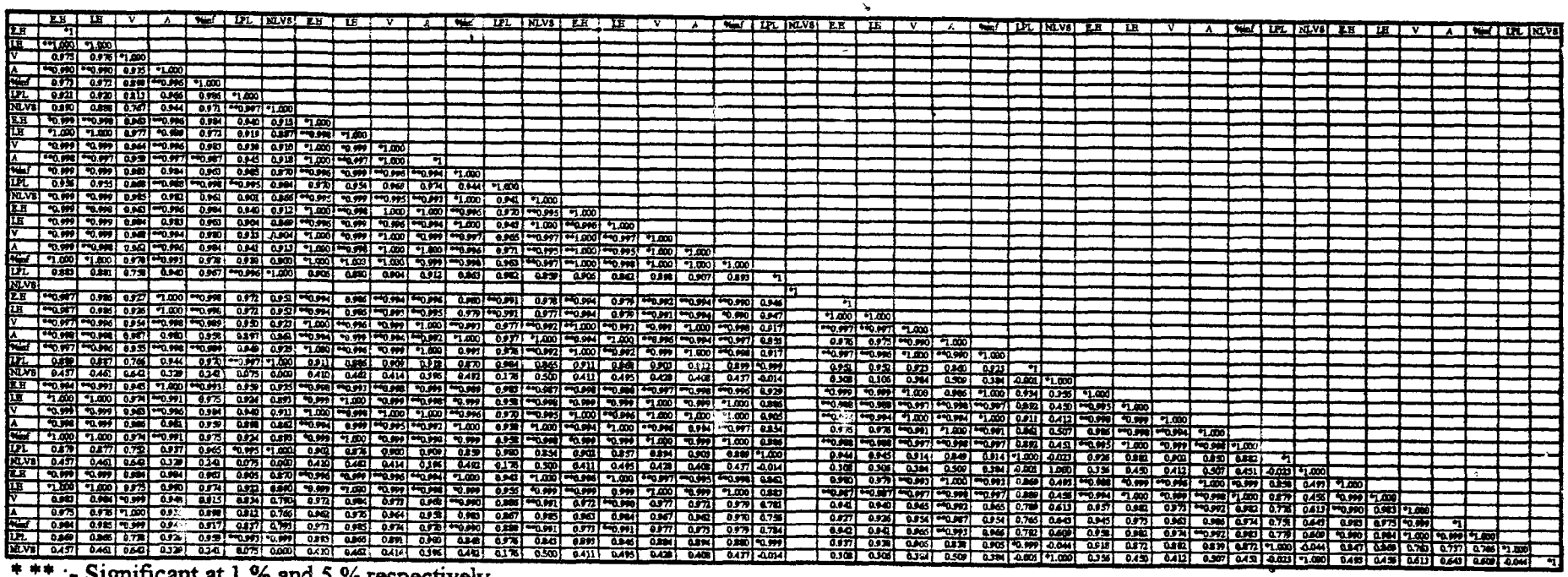
*,** :- Significant at 1 % and 5 % respectively.

Table-70: - Correlation co-efficient (r) values among various infection levels and growth of crop plants from 30-180 days net house experiment in maize crops (mixed) in terrace land soil

	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS
E.H	*1.000																											
LH	**0.998	*1.000																										
V	0.795	0.827	*1.000																									
A	**0.990	**0.996	0.872	*1.000																								
%inf	*0.999	*1.000	0.822	**0.996	*1.000																							
LPL	**0.991	**0.997	0.871	*1.000	**0.996	*1.000																						
NLVS	0.961	0.975	0.932	**0.990	0.972	**0.990	*1.000																					
E.H	**0.996	**0.990	0.740	0.975	**0.991	0.975	0.933	*1.000																				
LH	*0.999	*1.000	0.823	*0.996	*1.000	**0.996	0.973	**0.991	*1.000																			
V	0.984	**0.992	0.891	*0.999	**0.991	*0.999	**0.995	0.965	**0.991	*1.000																		
A	*1.000	*0.999	0.805	**0.992	*1.000	**0.993	0.955	**0.995	*1.000	**0.987	*1																	
%inf	*0.999	**0.996	0.772	0.984	**0.997	0.985	0.950	*0.999	**0.996	0.977	*0.999	*1.000																
LPL	0.679	0.718	0.985	0.775	0.712	0.773	0.856	0.613	0.713	0.799	0.692	0.652	*1															
NLVS														*1														
E.H	**0.998	*1.000	0.829	**0.997	*1.000	**0.997	0.975	**0.989	*1.000	**0.993	*0.999	**0.995	0.721		*1													
LH	*0.999	**0.995	0.764	0.982	**0.996	0.983	0.946	*0.999	**0.995	0.974	**0.998	1.000	0.642		**0.994	*1.000												
V	**0.998	*1.000	0.830	**0.997	*1.000	**0.997	0.976	*0.989	*1.000	*0.993	*0.999	**0.995	0.722		*1.000	**0.994	*1.000											
A	*0.999	**0.996	0.772	0.984	**0.997	0.985	0.950	*0.999	**0.996	0.977	*0.999	*1.000	0.652		**0.995	*1.000	**0.995	*1.000										
%inf	*1.000	**0.997	0.781	**0.987	**0.998	**0.987	0.954	**0.998	**0.998	0.980	*0.999	*1.000	0.662		**0.997	*1.000	**0.997	*1.000	*1									
LPL	0.877	0.902	0.989	0.935	0.898	0.935	0.976	0.832	0.899	0.949	0.885	0.859	0.948		0.904	0.852	0.904	0.859	0.866	*1.000								
NLVS	*0.999	**0.994	0.762	0.982	**0.995	0.982	0.945	*0.999	**0.995	0.973	**0.998	*1.000	0.640		**0.994	*1.000	**0.994	*1.000	*1.000	0.850	*1.000							
E.H	*0.999	*1.000	0.816	**0.995	*1.000	**0.995	0.970	**0.993	*1.000	**0.990	*1.000	**0.997	0.705		*1.000	**0.996	*1.000	**0.997	**0.998	0.893	**0.996	*1.000						
LH	*0.999	**0.995	0.768	0.983	**0.996	0.984	0.948	*0.999	**0.996	0.975	**0.998	*1.000	0.646		**0.995	*1.000	**0.995	*1.000	*1.000	0.855	*1.000	**0.997	*1.000					
V	*1.000	*0.999	0.803	**0.992	*0.999	**0.992	0.964	**0.995	*0.999	0.986	*1.000	*0.999	0.689		*0.999	**0.998	*0.999	*0.999	*0.999	0.883	**0.998	*1.000	**0.998	*1.000				
A	*1.000	**0.997	0.778	0.986	**0.997	0.986	0.953	**0.998	**0.997	0.979	0.999	*1.000	0.658		**0.996	*1.000	**0.996	*1.000	*1.000	0.863	*1.000	**0.998	*1.000	*0.999	*1.000			
%inf	*0.999	**0.996	0.775	0.985	**0.997	0.985	0.951	*0.999	**0.997	0.978	*0.999	*1.000	0.655		*0.996	*1.000	*0.996	*1.000	*1.000	0.861	*1.000	**0.998	*1.000	*0.999	*1.000	*1.000		
LPL	0.891	0.915	0.984	0.946	0.911	0.945	0.982	0.849	0.912	0.958	0.899	0.874	0.938		0.916	0.868	0.917	0.874	0.881	*1.000	0.866	0.907	0.870	0.897	0.878	0.876	*1	
NLVS																												*1

*,** :- Significant at 1 % and 5 % respectively.

Table-71: - Correlation co-efficient (r) values among various infection levels and growth of crop plants from 30-180 days net house experiment in paddy crops (mixed) in terrace land soil



*,** :- Significant at 1 % and 5 % respectively.

Table-72: - Correlation co-efficient (r) values among various infection levels and growth of crop plants from 30-180 days net house experiment in potato crops (mixed) in terrace land soil

	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS
E.H	*1																											
LH	*0.999	*1.000																										
V	**0.991	0.986	*1.000																									
A	*0.999	*1.000	0.984	*1.000																								
%inf	**0.990	0.985	*1.000	0.983	*1.000																							
LPL	**0.994	**0.997	0.970	**0.998	0.969	*1.000																						
NLVS	0.839	0.819	0.904	0.814	0.906	0.774	*1.000																					
E.H	*1.000	*1.000	**0.990	*0.999	**0.989	**0.995	0.833	*1.000																				
LH	**0.994	**0.998	0.972	**0.998	0.970	*1.000	0.777	**0.996	*1.000																			
V	**0.988	0.981	*1.000	0.979	*1.000	0.964	0.914	0.986	0.966	*1.000																		
A	0.980	0.972	**0.998	0.970	**0.998	0.952	0.930	0.978	0.954	*0.999	*1																	
%inf	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1																
LPL	0.932	0.918	0.972	0.915	0.973	0.886	0.979	0.928	0.889	0.977	0.985	*1	*1															
NLVS	**0.990	**0.993	0.963	**0.996	0.962	*1.000	0.756	**0.992	*0.999	0.956	0.944	*1	0.873	*1.000														
E.H	**0.996	**0.998	0.974	*0.999	0.973	*1.000	0.784	**0.997	*1.000	0.968	0.957	*1	0.894	*0.999	*1.000													
LH	**0.990	**0.994	0.962	**0.995	0.961	*0.999	0.753	**0.991	*0.999	0.955	0.942	-1	0.871	*1.000	*0.999	*1.000												
V	0.982	0.975	**0.998	0.973	*0.999	0.956	0.926	0.980	0.958	*1.000	*1.000	*1	0.983	0.947	0.961	0.946	*1.000											
A	*1.000	*0.999	**0.992	*0.999	**0.991	**0.993	0.842	*1.000	**0.994	**0.988	0.981	*1	0.934	**0.990	**0.995	**0.989	0.983	*1										
%inf	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1.000	*1		*1.000	-1.000	*1.000	*1	*1								
LPL	0.961	0.950	**0.989	0.948	**0.990	0.925	0.957	0.958	0.927	**0.993	**0.997	*1	*0.996	0.914	0.931	0.912	**0.996	0.963	*1	*1								
NLVS	**0.990	**0.995	0.963	**0.996	0.962	*1.000	0.756	**0.992	*0.999	0.956	0.944	*1	0.873	*1.000	*0.999	*1.000	0.947	**0.990	*1	0.914	*1.000							
E.H	**0.992	**0.996	0.967	**0.997	0.966	*1.000	0.765	**0.993	*1.000	0.960	0.948	*1	0.880	*1.000	*1.000	*1.000	0.952	**0.992	*1	0.919	*1.000	*1.000						
LH	**0.995	**0.998	0.974	*0.999	0.973	*1.000	0.784	**0.996	1.000	0.968	0.957	*1	0.893	*0.999	*1.000	*0.999	0.960	**0.995	*1	0.931	*0.999	*1.000	*1					
V	0.980	0.972	**0.998	0.970	**0.998	0.952	0.930	0.978	0.954	*0.999	*1.000	*1	0.985	0.944	0.957	0.942	*1.000	0.981	*1	**0.997	0.944	0.948	0.957	*1.000				
A	0.385	0.418	0.260	0.426	0.254	0.485	-0.179	0.395	0.479	0.235	0.195	-1	0.024	0.509	0.470	0.512	0.206	0.380	-1	0.115	0.509	0.497	0.470	0.195	*1.000			
%inf	**0.997	0.999	0.977	*0.999	0.976	*1.000	0.792	**0.997	*1.000	0.971	0.961	*1	0.899	**0.998	*1.000	**0.998	0.964	**0.996	*1	0.936	**0.998	*0.999	*1.000	0.961	0.459	*1.000		
LPL	0.952	0.940	0.984	0.937	0.985	0.912	0.965	0.949	0.915	**0.988	**0.994	*1	**0.998	0.901	0.919	0.899	**0.992	0.954	*1	*0.999	0.901	0.906	0.919	*0.994	0.084	0.924	*1	
NLVS																												*1

*,** :- Significant at 1 % and 5 % respectively.

Table-73: - Correlation co-efficient (r) values among various infection levels and growth of crop plants from 30-180 days net house experiment in maize crops (mixed) in jhum land soil

	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS
E.H	*1																											
LH	*1.000	*1.000																										
V	0.981	0.974	*1.000																									
A	**0.994	**0.990	**0.996	*1.000																								
%inf	*0.999	**0.997	**0.989	**0.998	*1.000																							
LPL	0.969	0.961	*0.999	**0.990	0.979	*1.000																						
NLVS	0.904	0.891	0.970	0.945	0.923	0.982	*1.000																					
E.H	**0.997	*0.999	0.963	0.983	**0.993	0.947	0.870	*1.000																				
LH	*1.000	*1.000	0.980	**0.994	*0.999	0.968	0.902	*0.998	*1.000																			
V	0.978	0.972	*1.000	**0.995	**0.987	*0.999	0.973	0.960	0.977	*1																		
A	*1.000	*1.000	0.979	0.993	*0.999	0.967	0.901	*0.998	*1.000	0.977	*1.000																	
%inf	*0.999	*1.000	0.971	**0.988	**0.996	0.956	0.884	*1.000	*0.999	0.968	*0.999	*1.000																
LPL	0.819	0.802	0.916	0.877	0.845	0.936	0.986	0.774	0.817	0.921	0.815	0.792	*1															
NLVS	0.904	0.891	0.970	0.945	0.923	0.982	*1.000	0.870	0.902	0.973	0.901	0.884	0.986	*1.000														
E.H	*1.000	*1.000	0.974	**0.990	**0.997	0.961	0.891	*0.999	*1.000	0.972	*1.000	*1.000	0.802	0.891	*1.000													
LH	**0.998	*1.000	0.968	0.986	**0.995	0.953	0.878	*1.000	*0.999	0.964	*0.999	*1.000	0.785	0.878	*1.000	*1.000												
V	*1.000	*1.000	0.980	**0.994	*0.999	0.968	0.903	**0.997	*1.000	0.978	*1.000	*0.999	0.818	0.903	*1.000	**0.998	*1.000											
A	*1.000	*0.999	0.982	**0.995	*0.999	0.971	0.907	**0.997	*1.000	0.980	*1.000	*0.999	0.824	0.907	*0.999	**0.998	*1.000	*1.000										
%inf	*1.000	*1.000	0.978	**0.993	**0.998	0.963	0.898	**0.998	*1.000	0.975	*1.000	*0.999	0.812	0.898	*1.000	*0.999	*1.000	*1.000	*1									
LPL	0.716	0.693	0.839	0.788	0.748	0.867	0.946	0.663	0.714	0.846	0.711	0.684	**0.987	0.946	0.693	0.675	0.715	0.722	0.707	*1.000								
NLVS	**0.997	*0.999	0.961	0.982	**0.992	0.943	0.866	*1.000	**0.997	0.958	**0.997	*0.999	0.770	0.866	*0.999	*1.000	**0.997	**0.996	**0.998	0.657	*1.000							
E.H	*1.000	*0.999	0.981	**0.994	*0.999	0.969	0.905	*0.997	*1.000	0.979	*1.000	*0.999	0.821	0.905	*0.999	**0.998	*1.000	*1.000	*1.000	0.718	**0.996	*1.000						
LH	*0.999	*1.000	0.972	**0.989	**0.997	0.958	0.887	*0.999	*0.999	0.970	*1.000	*1.000	0.797	0.887	*1.000	*1.000	*0.999	*0.999	*1.000	0.689	*0.999	*0.999	*1.000					
V	*1.000	*1.000	0.981	**0.994	*0.999	0.969	0.905	**0.997	*1.000	0.978	*1.000	**0.999	0.820	0.905	*1.000	**0.998	*1.000	*1.000	*1.000	0.718	**0.997	*1.000	*0.999	*1.000				
A	*1.000	*1.000	0.977	**0.992	**0.998	0.964	0.897	**0.998	*1.000	0.975	*1.000	*1.000	0.810	0.897	*1.000	*0.999	*1.000	*1.000	*1.000	0.705	**0.998	*1.000	*1.000	*1.000	*1.000			
%inf	*1.000	*1.000	0.978	**0.993	**0.998	0.966	0.899	**0.998	*1.000	0.976	*1.000	**0.999	0.813	0.899	*1.000	*0.999	*1.000	*1.000	*1.000	0.709	**0.997	*1.000	*1.000	*1.000	*1.000	*1.000		
LPL	0.643	0.621	0.781	0.723	0.678	0.814	0.909	0.585	0.640	0.789	0.638	0.608	0.966	0.909	0.621	0.598	0.642	0.650	0.634	**0.995	0.579	0.646	0.614	0.645	0.631	0.635	*1	
NLVS																												*1

*,** :- Significant at 1 % and 5 % respectively.

Table-74: - Correlation co-efficient (r) values among various infection levels and growth of crop plants from 30-180 days net house experiment in paddy crops (mixed) in jhum land soil

	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS
E.H	*1																																									
LH	**0.996	*1.000																																								
V	0.983	0.962	*1.000																																							
A	*1.000	**0.996	0.982	*1.000																																						
%inf	**0.998	*1.000	0.968	**0.998	*1.000																																					
LPL	**0.990	*0.999	0.948	*0.991	**0.998	*1.000																																			
NLVS	0.863	0.813	0.942	0.862	0.826	0.786	*1.000																																			
E.H	**0.996	*1.000	0.961	**0.996	*1.000	*0.999	0.812	*1.000																																		
LH	**0.997	*1.000	0.966	**0.997	*1.000	**0.998	0.823	*1.000	*1.000																																	
V	**0.997	0.985	**0.995	**0.996	**0.988	0.976	0.902	0.985	**0.988	*1.000																																
A	**0.997	*1.000	0.966	**0.997	*1.000	**0.998	0.824	*1.000	*1.000	**0.988	*1																															
%inf	**0.996	*1.000	0.964	**0.997	*1.000	*0.999	0.818	*1.000	*1.000	0.986	*1.000	*1.000																														
LPL	0.963	0.934	0.996	0.962	0.941	0.916	0.968	0.933	0.940	0.982	0.940	0.936	*1.000																													
NLVS	0.651	0.578	0.780	0.648	0.596	0.540	0.945	0.576	0.592	0.711	0.593	0.584	0.832	*1.000																												
E.H	**0.994	*1.000	0.956	**0.994	*0.999	*1.000	0.802	*1.000	*0.999	0.981	*0.999	*1.000	0.926	0.562	*1.000																												
LH	**0.992	*0.999	0.951	**0.992	**0.998	*1.000	0.792	*0.999	*0.999	0.978	*0.999	*0.999	0.920	0.548	*1.000	*1.000																											
V	**0.991	*0.999	0.950	**0.992	**0.998	*1.000	0.789	*0.999	*0.998	0.977	**0.998	*0.999	0.918	0.544	*1.000	*1.000	*1.000																										
A	**0.994	*1.000	0.956	**0.994	*0.999	*1.000	0.802	*1.000	*0.999	0.981	*0.999	*1.000	0.927	0.563	*1.000	*1.000	*1.000	*1																									
%inf	**0.992	*0.999	0.952	**0.992	**0.998	*1.000	0.792	*0.999	*0.999	0.978	*0.999	*0.999	0.920	0.549	*1.000	*1.000	*1.000	*1.000	*1.000																								
LPL	0.959	0.929	**0.995	0.958	0.936	0.910	0.971	0.928	0.935	0.979	0.935	0.931	*1.000	0.840	0.921	0.914	0.912	0.921	0.915	*1.000																					
NLVS	0.983	**0.996	0.932	0.984	**0.993	*0.999	0.756	**0.996	**0.994	0.965	**0.994	**0.995	0.896	0.500	**0.997	**0.998	*0.999	**0.997	**0.998	0.890	*1.000																				
E.H	**0.996	*1.000	0.963	**0.996	*1.000	*0.999	0.816	*1.000	*1.000	0.986	*1.000	*1.000	0.935	0.582	*1.000	*0.999	*0.999	*1.000	*0.999	0.930	*0.995	*1.000																				
LH	**0.996	*1.000	0.963	**0.997	*1.000	*0.999	0.817	*1.000	*1.000	0.986	*1.000	*1.000	0.935	0.583	*1.000	*0.999	*0.999	*1.000	*0.999	0.930	**0.995	*1.000	*1.000																			
V	**0.995	*1.000	0.959	**0.995	*1.000	*0.999	0.808	*1.000	*1.000	0.983	*1.000	*1.000	0.930	0.571	*1.000	*1.000	*0.999	*1.000	*1.000	0.923	**0.996	*1.000	*1.000	*1.000																		
A	**0.998	*0.999	0.971	*0.999	*1.000	**0.997	0.834	*0.999	*1.000	0.991	*1.000	1.000	0.946	0.608	0.998	**0.997	**0.997	**0.998	**0.997	0.942	**0.992	*0.999	*1.000	*0.999	*1.000																	
%inf	0.711	0.643	0.828	0.708	0.659	0.607	0.968	0.641	0.656	0.766	0.657	0.649	0.875	**0.997	0.627	0.615	0.611	0.628	0.616	0.881	0.569	0.647	0.647	0.636	0.671	*1.000																
LPL	0.946	0.912	**0.989	0.945	0.920	0.892	0.981	0.911	0.919	0.969	0.919	0.915	**0.998	0.862	0.903	0.896	0.894	0.904	0.897	*0.999	0.870	0.914	0.914	0.908	0.926	0.901	*1.000															
NLVS	0.983	**0.996	0.932	0.984	**0.993	*0.999	0.756	**0.996	**0.994	0.965	**0.994	**0.995	0.896	0.500	**0.997	**0.998	*0.999	**0.997	**0.998	0.890	*1.000	**0.995	**0.995	**0.996	**0.992	0.569	0.870	*1														
E.H																													*1													
LH																														*1												
V																															*1											
A																																*1										
%inf																																	*1									
LPL																																		*1								
NLVS																																			*1							
E.H																																				*1						
LH																																					*1					
V																																						*1				
A																																							*1			
%inf																																								*1		
LPL																																									*1	
NLVS																																										1

*,** :- Significant at 1 % and 5 % respectively.

Table-75: - Correlation co-efficient (r) values among various infection levels and growth of crop plants from 30-180 days net house experiment in potato crops (mixed) in jhum land soil

	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS	E.H	LH	V	A	%inf	LPL	NLVS
E.H	*1																																		
LH	*1	*1																																	
V	*1	0.978	*1.000																																
A	*1	**0.997	0.958	*1.000																															
%inf	*1	**0.994	0.951	*1.000	*1.000																														
LPL	*1	**0.988	*0.999	0.971	0.965	*1.000																													
NLVS		0.977	0.911	**0.991	**0.994	0.931	*1.000																												
E.H	*1	*1.000	*1.000	*1.000	*1.000	*1.000	*1	*1																											
LH	-1	0.894	0.782	0.928	0.937	0.813	0.970	-1	*1																										
V	*1	**0.998	**0.990	**0.989	0.985	**0.996	0.961	*1	0.863	*1.000																									
A	*1	**0.996	0.956	*1.000	*1.000	0.970	**0.992	*1	0.931	**0.988	*1.000																								
%inf	*1	0.985	0.928	**0.996	**0.998	0.946	*0.999	*1	0.958	0.972	**0.996	*1.000																							
LPL	*1	**0.996	**0.993	0.985	0.981	**0.998	0.954	*1	0.851	*1.000	0.984	0.966	*1.000																						
NLVS	*1	0.953	**0.995	0.925	0.916	**0.989	0.866	*1	0.717	0.971	0.923	0.887	0.976	*1.000																					
E.H	*1	*1.000	*1.000	*1.000	*1.000	*1.000	*1	*1	-1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1																				
LH	*1	0.984	0.925	**0.995	**0.997	0.943	*0.999	*1	0.960	0.970	**0.996	*1.000	0.964	0.884	*1	*1																			
V	*1	**0.987	*0.999	0.970	0.965	*1.000	0.930	*1	0.811	**0.995	0.969	0.945	**0.997	**0.989	*1	0.943	*1.000																		
A	*1	**0.997	**0.991	**0.987	0.983	**0.997	0.958	*1	0.858	*1.000	0.986	0.969	*1.000	0.973	*1	0.967	**0.996	*1.000																	
%inf	*1	0.988	0.935	**0.998	*0.999	0.952	**0.998	*1	0.952	0.976	**0.998	*1.000	0.971	0.896	*1	*1.000	0.951	0.974	*1.000																
LPL	*1	*1.000	0.982	**0.995	**0.992	**0.990	0.972	*1	0.885	*0.999	*0.994	0.981	**0.998	0.959	*1	0.980	**0.990	**0.998	0.985	*1.000															
NLVS		0.977	0.911	**0.991	**0.994	0.931	*1.000	*1	0.970	0.961	**0.992	*0.999	0.954	0.866	*1	*0.999	0.930	0.958	**0.998	0.972	*1.000													
E.H	*1	*1	*1	*1	*1	*1	*1	*1	-1.000	*1.000	*1.000	*1.000	*1.000	*1.000	*1	*1.000	*1.000	*1.000	*1.000	*1.000	*1	*1												
LH	-1	0.970	0.899	**0.987	**0.990	0.920	*0.999	-1	0.976	0.953	**0.988	**0.997	0.945	0.852	-1	**0.998	0.919	0.949	**0.996	0.963	*1.000	-1	*1											
V	*1	**0.994	**0.994	0.982	0.978	**0.998	0.949	*1	0.843	*0.999	0.982	0.962	*1.000	0.979	*1	0.960	**0.998	*1.000	0.967	**0.996	0.949	*1	0.940	*1.000										
A	*1	**0.994	0.951	*0.999	*1.0000	0.963	**0.993	*1	0.936	0.986	*1.000	**0.998	0.982	0.917	*1	**0.997	0.965	0.984	*0.999	**0.992	**0.994	*1	**0.990	0.979	*1.000									
%inf	*1	0.986	0.930	**0.996	**0.998	0.948	**0.998	*1	0.956	0.974	**0.997	*1.000	0.968	0.891	*1	*1.000	0.947	0.971	*1.000	0.983	*0.999	*1	**0.997	0.964	**0.998	*1.000								
LPL	-1	0.972	0.903	**0.988	**0.991	0.923	*0.999	-1	0.974	0.955	**0.989	**0.998	0.948	0.857	-1	**0.998	0.923	0.952	**0.997	0.968	*1.000	-1	*1.000	0.943	**0.991	**0.998	*1.000							
NLVS	*1	0.953	**0.995	0.924	0.915	**0.988	0.866	*1	0.717	0.971	0.923	0.887	0.976	*1.000	*1	0.884	**0.989	0.973	0.896	0.959	0.866	*1	0.852	0.979	0.917	0.891	0.857	*1						
E.H																													1					
LH																														1				
V																															1			
A																																1		
%inf																																	1	
LPL																																		1
NLVS																																		1

*,** :- Significant at 1 % and 5 % respectively.

Results

It was observed that the transfer of Nitrogen (%), phosphorus (%), and Potassium (%) in valley practice soil was highest in double number of spore inoculated treatments, moderate in half number of spore inoculated treatments and least in control treatment, followed by moderate level of transfer of nutrients (N,P and K) rate in terrace practice soil and in jhum practice soil least transfer rate was seen.(Figs-18,19,20). The transfer of N(%) was seen to be highest in maize(1.238±0.015), moderate in potato (1.208±0.025) , and least in paddy (1.127±0.025) crops of valley practice soil in 30 days treatments.Whereas in 180 treatment the transfer level was different in three different crops. i.e maize (1.282±0.045), moderate in paddy (1.232±0.035) and least in potato (1.110±0.025) crops, whereas in terrace practice soil the N(%) rate of transfer in three different treatments were highest in maize (1.236±0.045) , paddy (1.216±0.025) , and potato (1.099±0.105) . In case of jhum practice soil the rate of transfer of N(%) was highest in maize (1.279±0.035), moderate in paddy (1.268±0.205) and least in potato (1.211±0.015) (Fig-19).It was seen that the transfer rate of P(%) in valley practice soil was highest in maize (0.139±0.005), moderate in paddy (0.132±0.005) and least in potato (0.112±0.005) followed by moderate rate in maize (0.127±0.105), paddy (0.125±0.085) and potato (0.116±0.065) of terrace practice soil and least transfer rate in jhum practice i.e maize (0.104±0.005) , paddy (0.101±0.105) and potato (0.098±0.305) in 90 days . (Fig-20).The uptake rate of K(%) was found to be more in 90 days in all the three separate crops i.e maize (0.952±0.005), paddy (0.946±0.005) and potato (0.911±0.105) and it started declining from 150-180 days (0.859±0.005-0.918 ±0.005) in valley practice soil (Fig-18),

0.108±0.001) potato (0.099±0.005–0.101±0.005) starting from 30-120 days. Whereas the potassium transfer (%) was highest in valley practice soil, moderate in terrace practice soil and least in jhum practice soil (Fig-21).

It was seen from the comparative study of both pure and mixed cropping systems of the pot experiment that the transfer of nutrients i.e(N , P , and K) in pure cropping system (single cropping) was more than mixed cropping systems. And starting from 150-180 days it was seen that except maize crops other two crops(potato and paddy) were dead. It was observed that in 30 days pure cropping system of potato crop in control(X) treatments the number of vesicles, arbuscules and % infection was zero and the growth of plant i.e in valley practice soil (11.30±0.023cm) , terrace practice soil (8.23±0.034) and jhum practice soil (5.60±0.022cm) and the number of leaves were 4 in each agricultural practices and inoculation levels. And the infection (%) was 48.02± .051 in valley practice soil in maize crops , 42.91±0.054 in in terrace practice soil , 32.02±0.033 in jhum practice soil maize crops and least in control treatments i.e valley (11.61±0.035 cm) , terrace (7.50±0.054 cm) and jhum (7.50 ±0.009cm).and the number of leaves of maize crops increased up to 5 in valley, 5 in terrace and 4 in jhum practice soil. In 30 days maize cropping system of control treatments , the growth of crop plants in valley practice soil was (16.20±0.022cm) , terrace (16.5±0.044cm) and jhum(15.8±0.022cm) and in half number of inoculated spore treatments the infection were (48.01±0.05) % in valley practice soil, (42.10±0.025)% in terrace practice soil and (36.01±0.025)% in jhum practice soil. Whereas in double number of inoculated spore treatments the growth of maize plants were higher than half number of inoculated treatments i.e in valley practice soil (16.80±0.047cm) , terrace practice soil(16.00±0.025cm) and jhum practice soil (16.30

±0.053 cm) In paddy cropping systems (pure) , the growth of crops was highest in valley pracrice soil (16.20 ±0.058 cm) , followed by terrace practice soil (9.60±0.052 cm) and jhum practice soil (8.7±0.035 cm).In half number of inoculated spore treatments the growth of maize plants was highest in valley practice soil (11.90±0.051cm) , followed by terrace practice soil (11.40±0.043 cm) and jhum practice soil (9.70±0.015 cm).In 60 days pure cropping systems an increase in the growth of crop plants and number of leaves was observed as compared to 30 days and in control treatments the growth of potato crops in valley practice soil was (16.70±0.012 cm), terrace practice soil (11.30±0.015 cm) and jhum practice soil (7.20±0.05 cm), whereas the infection level in 30 days maize crops was in valley practice soil (56.02±0.065)% , terrace practice soil (38.01±0.065)% and in jhum practice soil (38.21 ±0.023)% followed by increased growth of potato crops in double number of spore inoculated treatments than control treatments i.e in valley practice soil (19.70±0.054 cm), terrace practice soil (13.12±0.059 cm) and jhum practice soil (10.40±0.035 cm) . In 60 days maize (pure) cropping systems the growth was higher than paddy and potato crops , whereas in control treatments of valley practice soil (24.30±0.067 cm), terrace practice soil (22.60±0.023 cm) and jhum practice soil (18.50±0.05 cm).

It was seen that in double number of inoculated treatments the growth of maize plants were higher than half number and control treatments i.e in valley practice soil (28.20±0.052 cm) , terrace practice soil (24.62±0.025 cm) and in jhum practice soil (22.31±0.215 cm) and in paddy (pure) cropping systems of control treatments the growth in 90 days was in valley practice soil (16.30±0.105 cm) , terrace practice soil

(12.34±0.105 cm) and jhum practice soil (9.80±0.205 cm) and in half number of inoculated spore treatments the growth of paddy plants were i.e in valley practice soil (12.60±0.046 cm) , terrace practice soil (10.80±0.05cm) and in jhum practice soil (7.40±0.05 cm) followed by an increased level of growth and infection(%) in double number of inoculated treatments i.e growth in valley practice soil (22.30±0.025cm) terrace practice soil (19.31±0.025cm) and in jhum practice soil (12.62±0.052cm) , in 60 days cropping systems , whereas it was seen that in 90 days pure cropping systems the infection(%) rate and growth of crop plants were higher than 30 and 60 days. Whereas in control treatments the length of potato plants were in valley practice soil (22.20±0.115cm), terrace practice soil (16.30±0.046cm) and in jhum practice soil (11.32±0 .605cm) followed by an increase in infection level than previous studies i.e in valley practice soil (58.10±0.05)%, terrace practice soil (53.23±0.305)% and jhum practice soil (42.30±0.405)%. It was seen from the 90 days studies of potato crops in pure cropping systems the growth was highest in double number of inoculated treatments , moderate in half number and least in control treatments. In 90 days paddy cropping systems showed highest growth in double number of inoculated treatments than half number of inoculated and control treatments i.e in valley practice soil (24.69±0.025cm), terrace practice soil (22.66±0.105cm) and jhum practice soil (16.35±0.053 cm).

Whereas 90 days paddy crops showed moderate growth rate than potato and highest maize plant growth i.e in valley practice soil (29.39±0 .035cm), terrace practice soil (25.02±0.055 cm) and jhum practice soil (16.20±0.078 cm) (Tables:-44-48).In 120 days pure cropping systems the paddy crops were having moderate growth

i.e in valley practice soil (40.10±0.054 cm) terrace practice soil (33.84±0.059 cm) and jhum practice soil (30.11±0.022 cm) followed by increased (%) level of infection in valley practice soil (63.00±0.025)% , terrace practice soil (58.10±0.035)% and jhum practice soil (41.01±0.052)%. In 150 days pure cropping systems the highest growth rate was found in maize plants i.e in valley practice soil (40.19±0.057cm) , terrace practice soil (33.80±0.05cm) and jhum practice soil (30.01±0.054 cm) followed by increased number of leaves than other periods i.e 30-120 days (Tables-45and 46).In 180 days almost same observation was seen like 150 days.

In mixed cropping systems of pot experiment it was observed that in 30 days the infection(%) was in potato crops of valley practice soil(48.12±0.035)% , terrace practice soil(42.16±0.074)% and in jhum practice soil (32.16±0.033)% and length of potato plants were in valley practice soil (9.80±0.064 cm) , in terrace practice soil (9.65±0.012cm) and in jhum practice soil(6.12±0.011 cm) in half number of inoculated spore treatments. Whereas in double number of inoculated spore treatments the infection level was more and more growth was observed in valley practice soil (10.31±0.052cm),terrace practice soil (10.30±0.043 cm) and in jhum practice soil (7.20±0.015cm).The growth of maize plants were highest in double number , moderate in half number and least in control treatments i.e valley practice soil (16.57±0.024cm) , terrace practice soil (17.80±0.075cm) and in jhum practice soil (11.30±0.025 cm).Paddy plants showed moderate growth than potato and highest growth was observed in maize plants i.e in valley practice soil (11.71±0.042cm) , terrace practice soil (11.40±0.405cm) , jhum practice soil (9.20±0.095cm) of double number of inoculated treatments (Table-47) followed by moderate growth in half number and

least growth rate in control treatments. In 60 days mixed cropping systems , the growth was higher in paddy and maize crops than 30 days and in 60 days maize cropping systems the % infection were in valley practice soil(56.02±0.095)%, terrace practice soil (48.05±0.075)% and jhum practice soil (36.01±0.015)%.During 90 days mixed cropping systems it was seen that the growth of maize crops were comparatively higher than paddy and potato crops i.e in valley practice soil (28.2±0.205cm) , in terrace practice soil (24.3±0.705cm) in jhum practice soil (16.20±0.051cm) in double number of inoculated and control treatments. In 120 days mixed cropping systems the growth was comparatively higher in maize crops than potato and paddy crops i.e in valley practice soil (30.20±0.025cm),terrace practice soil (26.24±0.085cm) jhum practice soil (18.34±0.015cm) followed by increase number of leaves 6 in valley practice soil , 6 in terrace practice soil and 5 in jhum practice soil (Tables-48 and 49). It was also observed that both paddy and potato crops were found to be dead during 150-180 days, only maize crops were alive, where the growth rate was highest in double number of inoculated treatments, moderate in half number and least in control treatments i.e valley practice soil (30.80±0.035cm), terrace practice soil (26.70±0.065cm) and jhum practice soil (18.80±0.105cm) followed by % infection level in valley practice soil (62.01±0.015)%, terrace practice soil (57.06±0.025)% and jhum practice soil (46.02±0.125)%. A difference in the growth rate was observed during 30, 60, 90 and 120 days, however between 150-180 days there was not much difference in the growth of maize crops. (Table-55).It was observed from the statistical analysis that the infection level i.e total number of external hyphae , internal hyphae , number of vesicles , number of arbuscules started increasing when the inoculated spores started increasing in all the three crops and were positively correlated (significant at 1% and 5 %) in pure cropping system.Whereas in mixed

cropping system only in maize crops the significance observed was (at 1 % and 5 %) , whereas potato and paddy crops showed some negative correlation. and potato did not show any significance at all during 180 days..(Table:-58-75)

Discussion

It was found that in pure cropping system (single crop), the uptake of nutrients (N, P, & K) from three different soil conditions i.e. valley, terrace and jhum practice soils to three different crops i.e. potato, maize and paddy were more in double number of inoculated spore treatments and moderate in half number of inoculated spore treatments and comparatively less in control treatments which may be due to the presence of inoculated VAM spores in double and half number of spore inoculated treatments (Omar,1996). It was seen that in valley practice soil , the N (%) transfer in maize plants was more i.e. (1.283±0.025-1.289±0.025) % in 180 days treatments followed by moderate quantity in paddy crops (1.233±0.035-1.236±0.035) % and least in potato crops (1.126±0.075–1.127±0.075) % which may be due to the different heights of the crops which created climatic variation (Francis, *et al* .,1986). whereas the P (%) transfer also varied from half number of spore inoculated treatments (0.016±.005-0.030±.005) % in potato crop and double number of inoculated spore treatments (0.716±.005-0.139±.005) % in valley practice soil from 30 days to 180 days and least uptake in control treatments (0.016±0.005-0.029±0.005) % in all the three crop plants may be due to the different levels of spore inoculation, whereas the K (%) transfer in maize plants of valley land soil were more (0.420±0.005- 0.952±0.005) % , paddy crops (0.400±0.005-1.013±0.005) % , moderate and least uptake in potato crops i.e. (0.520±0.005-0.919±0.005) % in double number of inoculated spores followed by moderate in half number of inoculated spores and least in control treatments which may be due to the height of the crop plants and spore difference. It was also found that the N (%) transfer in maize plants were more (1.123±.015-1.236±.015) % followed by moderate in paddy crops (1.206±0.045-1.216±0.045) % and least in potato crops (1.204 ±0.005-1.201±0.005) % in 180 days crop plants (single) followed by medium result in half number of inoculated spore treatments as

compared with the control treatments, which showed less uptake of nutrients . This may be due to the unequal presence of VAM spores and low bulk density (1.2±0.005-1.3±0.005) which causes low growth of spores and less aeration .Whereas the P (%) transfer rate in terrace land soil in 30 days old paddy crops showed more (0.062±0.005)% followed by least rate (0.058 ±0.005) % in potato crops and positively correlated with the inoculated VAM spores (significant at 1 % and 5 % respectively) , whereas the K (%) transfer of valley practice soil was more in all the three crop plants than terrace land soil may be due to the high bulk density (1.2-1.4) mg^{-3} in valley land soil than terrace land soil and also may be due to the soil climatic conditions. It was seen that in jhum land soil conditions the N (%) was more i.e.(1.283±0.085-1.286±0.085) % in 180 days old maize crops than valley and terrace land soil conditions may be due to the accumulation of more (N) (%) in jhum land soil due to the burning of vegetations and low bulk density (1.1-1.2)mg^{-3} (Nadian *et.al.*,1996).Whereas the P (%) transfer was least in jhum land soil in all the three crop plants i.e.(0.021±0.005-0.120±0.005) % than valley and terrace land soil conditions and it is negatively correlated with the inoculated spores .Whereas K (%) transfer in pure cropping systems of all the three crops were more in valley land soil than terrace and jhum land soil in 180 days experiments which may be due to more accumulation of K (%) in valley land soil , from the adjacent sides and due to the rainfall of water carrying the nutrients along with it and depositing in the valley land. The higher rate of P (%) transfer in terrace land soil in 30 days old paddy crop than that in potato crop may be due to the fibrous roots which penetrates easily and quickly in to the rhizospheric region and helps in transferring the previous existing nutrients. The higher K (%) transfer rate in valley land soil in all the three crop plants than that in terrace land soil may be due to plain land soil which can hold nutrient from various adjacent sides by heavy shower of rainfall and deposits , and also due to high rate of microbial decomposition rate in

valley land soil due to high moisture level throughout the year except summer season and which helps VAM spores for more uptake due to previous accumulated nutrients. .It was always seen that in double number of inoculated treatments the nutrient uptake and VAM compatibility were highest followed by half number of inoculated spore treatments and less in control treatments in three different crops may be due to proper watering , Soil and Sand ratio (3:1) , which created a suitable micro-edaphic conditions in the rhizosphere regions where VAM spores could survive for a longer period and helped in better uptake of nutrients and infection level (Wagner *et. al* . , 2001) and more VAM colonization was found in double number of inoculated treatments than half number of spore(Y) inoculated treatments and control treatments may be due to micro-edaphic situations caused by sand dilution (John and Rangarajan , 2001). It was seen that the infection levels and growth of crop plants were positively correlated among each other in three crops and in three practices soil conditions during the study period may be due to the inoculation of VAM spores and due the maintaince of proper micro-edaphic and micro-climatic situations which showed different result than control treatments.(Wagner *et.al* 2001).

GENERAL DISCUSSION

It was observed that the status of VAM i.e total number of spore population and infection levels were highest in valley practice than terrace and jhum practices may be due to the suitable temperature, pH, and nutrient level of soil (Clapp *et.al.*, 1995) and also presumably on account of previous contact with the infective hyphae in the crop fields (Jasper *et al* . ,1989), In terrace practice the moderate level of VAM status was seen may be due to low pH and nutrient levels of soil (Abbott *et al* . ,1984) whereas in jhum practice the VAM status was least compared with valley and terrace practices may be due to low moisture content of soil , acidic soil pH and burning of vegetations for shifting cultivation by farmers (Srivastava and Singh, 1991).It was found that the infection levels i.e number of external hyphae , internal hyphae , entry points , vesicles , arbuscules and % infections were mostly positively correlated (Table 7,8and 9) may be due to active hyphal growth and suitable soil characters.

It was seen that in three different agricultural practices the *Glomus*_species was dominant followed by least number of *Sclerosystis* & *Modicella* species may be due to the soil characterstics and their individualistic competitive ability (Johnson *et al.*, 1993). Whereas in jhum practice starting from Mar-Apr the spore number came down tremendeously may be due to the burning of vegetations for jhum cultivation (Mcgee *et.al* ,1996). It was also found that both in rhizospheric and earthworm casts, gut content soil starting from Oct- Feb the *Sclerocystis* and *Modicella* species came down than rest of the months, may be due to extreme cold temperature and acidic soil pH (Vogelzag *et.al.*, 1993) , the diversity of individualistic spore population was quite remarkable in jhum practice than valley and terrace practices may be due to high altitude (1600.25 m.s.l.) , acidic soil , and low moisture level of

soil (Saif ; 1983) From the diversity index table it was seen that *Sclerocystis* and *Modicella species* were least in number and more than index value may be due to influence of other dominant species. It was observed that the physico- chemical characterstics of valley practice soil was quite healthier than terrace and jhum practices and the pH of jhum land soil was acidic i.e 4.27 ±0.095 –4.71±0.095 in both 1996 and 1997 may be due to sloppy land which carried away the hydrogen ions from the experimental field and deposited in the bottom. It was seen that the N (%) of valley practices was more i.e 0.312±0.025–0.509±0.025 / g soil from Jan-Mar and 0.201±0.105–0.412±0.105 / g soil from Apr-Dec , may be due to plain land , high decomposition rate of existing vegetations due to high moisture content of soil by heavy shower of rain from adjacent mountains (Singh *et. al* . ; 1991) , similar characteristics were observed for P and K i.e. moderate level in terrace and least nutrient level in jhum practice in both 1996 and 1997. It was also reported that the organic carbon (%) content of jhum practice was more i.e. 6.501±0.065-8.510±0.065/ g soil from Mar-May, followed by less organic carbon (%) in rest of the experimental months may be due to burning of vegetations for shifting cultivation and mineralisation process (Robertson . ; 1983).

It was observed that in both pure and mixed cropping systems the uptake of nutrients (N,P & K) from different soil conditions i.e valley , terrace and jhum land soil to three separate crops i.e potato , maize and paddy were highest in double number (200) of inoculated spore treatments , moderate in half number (100) inoculated spore treatments and less in control treatments may be due to presence of variable number of inoculated spore treatments and may be due to VAM association by inoculated spore which increased the uptake of nutrients (Omar ; 1996) conditions where the N (%) uptake was less than valley and terrace land soil may be due to acidic soil pH (4.29-4.71) , which did not give

suitable atmosphere to the VAM spores (Ibijibijen *et. al.*; 1996). It was seen that in control treatments the P (%) transfer was less in all the three separate crops may be due to absence of VAM spores, whereas uptake rate was more in inoculated treatments of both pure and mixed cropping systems (Tarafdar and Marschner; 1994).It was seen that in three field conditions in three different crops and three different treatment levels the nutrient uptake i.e N (%) , P (%) and K (%) was mostly positively correlated among each other from 30- 120 days both in pure and mixed cropping systems may be due to the inoculated spores , soil nutrients and physiological and functional activities at primary time periods than rest time intervals i.e 150-180 days. Whereas it was found that the nutrient transfer was relatively less in control treatments than inoculated treatments of net house experiment i.e N (%) in maize crops (1.283±0.105-1.286±0.105) % in 180 days followed by moderate transfer rate in paddy crops (1.233±0.505-1.236±0.505) % and least in potato crops (1.126 ±0.075-1.127±0.075) % may be due to variable heights of crop plants which disturbed similar climatic level to all the crops (Francis *et al* . ; 1986).It was also seen that in jhum land soil conditions the N (%) was highest i.e (1.283±0.065-1.286±0.065) % in 180 days old maize crops than valley and terrace land soil conditions may be due to accumulation of more N (%) in jhum land practices , where burning of vegetations used to be there every year (Nadian *et. al* . ; 1996).Where as the P (%) transfer was least in jhum land soil conditions in three different crop plants i.e (0.021±0.005–0.120 ±0.005) % than valley and terrace land soil and it was positively correlated with inoculated spores significant at 1 % and 5 % respectively. Whereas it was found that in mixed cropping system starting from 150-180 days the paddy and potato crops were dead may be due to unsuitable micro-climatic situations and high growth of maize crops which created obstacles for free micro and macro climatic situations among the crop plants (Read *et. al.*; 1976). It was also seen from the net house experiment that starting from 30-120

days in both pure and mixed cropping systems in three different soil conditions the nutrient uptake levels were significant at 1 % and 5 % respectively than 150-180 days.

It was found that the VAM compatibility (number of external hyphae , internal hyphae , vesicles , arbuscules and % infection) and growth of crops plants (length of crop plants and number of leaves) in three different crops and three different agricultural practices and in three different treatment levels were positively correlated among each other (Significant at 1 % and 5 %) respectively in pure cropping systems and not much positive correlation was seen in mixed cropping system may be due to the physiological and functional activities of the crop plants as well as the presence of tuber and different types of roots and its dynamics in the rhizospheric soil which created obstacles for the potato and paddy crops.

SUMMARY

For the present investigation three sites differing in agricultural practices with three different crops viz. potato , maize and paddy were selected.These were (i) valley practice at Kyntonmassar (altitude 1000 m.s.l) (ii) terrace practice near Sanker rehabilitation centre (altitude 1100 m.s.l) and jhum practice at Umphyrnai near Smit (altitude 1600 m.s.l or 1625.25 m.s l).

For the isolation of endogonaceous spores from rhizosphere soil , cast and gut content of earthworm , wet sieving decantation method of Gerdeman and Nicolson (1963) was followed. It was found that the endogonaceous spores isolated from rhizosphere soil , cast and gut content of earthworm were highest in valley practice followed by that in terrace and the least was found in jhum practice. The highest number of spores were found in rhizosphere soil as compared to cast and gut content in all the three agricultural practices.

For mycorrhizal infection , Phillips and Hayman's (1970) method was followed. It was observed that the VAM infection level i.e total number of external hyphae , total number internal hyphae , total number of entry points , total number of vesicles , total number of arbuscules and percentage infection was highest in soil of valley practice followed by terrace and least was recorded in jhum practice during the study period . It was also found that the percentage infection was highest in potato crops as compared to maize and paddy crops in three agricultural practices. The infection level in maize , paddy and potato crops of valley practice were mostly positively correlated ,

in terrace practice it was found that in all the three crops the external hyphae was negatively correlated with entry points and internal hyphae , and in jhum practice it was found that in maize , paddy and potato crops the external hyphae and entry points were positively correlated with internal hyphae , vesicles, arbuscules and percentage infection.

. For the estimation of hyphal biomass, Ride and Drysdale's (1972) method was followed. It was found that the hyphal biomass in soil was maximum in valley practice followed by terrace and minimum was found in jhum practice . During the months of Mar-May , the hyphal biomass declined in the soil of jhum practice . Maximum hyphal biomass was recorded in paddy field soil than that in case of maize and minimum in potato field.

For the diversity of VAM fungi under different agricultural practices , the spores were isolated by wet sieving and decantation method (Gerdeman and Nicolson ,1963). The isolated VAM spores were identified as *Glomus fasciculatum* , *Gigaspora sp* , *Acaulospora sp* , *Sclerocystis sp* and *Modicella sp* . However , *Glomus fasciculatum* was found to be the dominant in all the three agricultural soils. Maximum spores were isolated in cast and gut content of earthworm collected from valley practice followed by that in terrace and minimum was recorded in jhum practice.

For the estimation of soil pH , moisture content and bulk density the methods described by Allen (1974) were followed ..The percentage moisture content of the soil was maximum in valley land (15.16-55.41 in 1996 and 14.23-45.31 in 1997) followed by terrace land (14.12.-34.23 in 1996 and 14.18-25.30 in 1997) and minimum moisture content (12.23-36.12 in 1996 and 12.19-35.51 in 1997) was recorded

in jhum practice. The pH of the soil was acidic in nature. The pH of the soil collected from valley practice ranged between 5.12-5.41 in 1996 and 5.02-5.66 in 1997. In terrace practice, the soil pH ranged between 5.01-5.72 in 1996 and 4.90-5.86 in 1997 , whereas in jhum practice the soil pH ranged between 4.29-4.72 in 1996 and 4.05-4.73 in 1997. The bulk density of terrace practice was highest than that in valley and minimum in jhum practice.

For the estimation of total nitrogen , available phosphorus , and available potassium of the soil samples , semimicro-kjeldahl method, molybdenum blue method and flame photometer method were followed respectively. Walkley and Black's rapid titration method (1934) was followed for the estimation of organic carbon . It was found that percentage nitrogen content of soil in valley practice was highest (0.201-0.512) followed by terrace (0.102-0.418) and least in jhum practice (0.101-0.323). Similar trend was found in case of available phosphorus , available potassium and organic carbon content of the soil during the study periods .

For the role of VAM fungi in nutrient uptake from soil of three different agricultural practices to three different crop plants (potato , maize and paddy) , the experiment was conducted in three different agricultural practices taking an area of 1m length x 1m breadth size.The soil was sterilised with 4 % formalin and in each field 50 sterilised paddy seeds , 20 sterilised maize seeds and 10 sterilised potato seeds were sown separately in pure cropping system as well as in combination in mixed cropping system. In the first set of experimental plot , soils were inoculated with 200 number of VAM spores (Z) i.e (*Glomus fasciculatum* , *Gigaspora sp* , and *Sclerocystis*

sp. mixed together) in pure and mixed cropping systems. In the second set of experimental plot , soils were inoculated with 100 number of VAM spores (Y) of same species in pure and mixed cropping systems. The third set of experimental plot was treated as control (X) , where no VAM spores were inoculated in both pure and mixed cropping systems.The study was carried out for a period of six months . For each crop , samplings were done at 30 days interval. N (%) , P (%) and K (%) of soil were analysed following semimicro-kjeldahl method , molybdenum blue method and flame photometer method respectively (Allen , 1974). It was observed that the uptake rate of nitrogen (%) , phosphorus (%) and potassium (%) in valley practice was highest in the set inoculated with double number (Z) of spores, moderate in the set inoculated with half number (Y) of spores and least was found in control set in three different crops of both pure and mixed cropping systems.

The N (%) , P (%) and K (%) of three different crops (potato, maize and paddy) were also analysed at 30 days interval . For the analysis of total nitrogen semimicro-kjeldahl method was followed . Triacid digestion method was followed for the analysis of phosphorus and potassium (Allen , 1974). It was found that the N (%) , P (%) and K (%) of different crops were maximum in double number of inoculated set than that in half number of inoculated set and minimum uptake rate was found in control set. It was found that in three field conditions in three different crops (potato, maize and paddy) and in different treatment levels , the nutrient uptake rate i.e N (%) , P (%) and K (%) were positively significant with different treatment levels from 30-120 days in pure cropping system ($r = 1.000$ and 0.997 at 1 % and 5 % respectively). Whereas from 150-180 days negative correlation was found. In

mixed cropping system , positive correlation was found till 90 days with different treatment levels in three different crops.. In maize crops of both pure and mixed cropping systems the nutrient uptake was maximum and minimum nutrient uptake was recorded in potato crops. In all the three different agricultural fields the nutrient i.e N (%) , P (%) and K (%) uptake was found to be maximum in valley practice followed by terrace and minimum was recorded in jhum practice in both pure and mixed cropping systems.

For the interspecies interaction of crops and VAM compatibility in soil of three different agricultural practices (valley , terrace and jhum) in three different crop plants (potato, maize and paddy) the experiment was conducted in pots. The soil from three different agricultural practices were collected and 10 kg of soil from each crop field was sterilised in autoclavable polythene bags at 15 psi in an autoclave for one hour. Then the sterilised soils were transferred to different earthen pots. In each pot sterilised seeds of paddy (10) , maize (5) and potato (3) were sown separately for pure cropping system as well as in combination for mixed cropping system. In the first set of pots , soils were inoculated with 200 number (Z) of VAM spores (*80 Glomus fasciculatum* , *80 Gigaspora sp* , and *40 Sclerocystis sp*) separately in pure and mixed cropping systems. In the second set , 100 spores number (Y) i.*e 40 Glomus fasciculatum , 40 Gigaspora sp and 20 Sclerocystis sp* were inoculated separately in pure and mixed cropping systems. In the third set , no VAM spores were inoculated which was treated as control set (X) in both pure and mixed cropping system. Three replicates were maintained for each set for each cropping system (pure and mixed). The study was carried out for a period of six months.

The VAM compatibility (total number of external hyphae , total number internal hyphae, total number of vesicles, total number of arbuscules and percentage infection) and growth of crops (length of crops and number of leaves) were estimated at 30 days interval by Phillips and Hayman's (1970) method. The nutrients i.e N (%) , P (%) and K (%) of soils were analysed following the methods of semimicro-kjeldahl . molybdenum blue, and flame photometer respectively (Allen ,1974). The nutrients of three separate crops (potato , maize and paddy) were also analysed at 30 days interval following the methods of semimicro-kjeldahl and triacid digestion respectively (Allen ,1974). It was observed that N (%) , P (%) and K (%) in the soil of valley practice were highest in the pots inoculated with double number (200) of spores , moderate in half number (100) of spores and least in control pots followed by moderate uptake rate i.e N (%) , P (%) and K (%) in the soil of terrace practice and the soil of jhum practice showed least nutrient uptake rate in both pure and mixed cropping system.

It was also observed that the infection level and growth of crop plants were highest in the set of valley practice in double number of inoculated spores (Z) followed by half number of inoculated spores (Y) and lowest infection was found in control (X) sets, whereas, terrace practice soil showed moderate growth of crop plants and in jhum practice least growth of crop plants was observed in both pure and mixed cropping systems. The maximum nutrient uptake rate was found in pure cropping system than mixed cropping systems.

It was observed that in three different soil conditions and crops the nutrient uptake and VAM cvompatibility were positively

correlated with the inoculated spores (r =1.000 and 0.997 significant at 1 % and 5 % respectively). It was also found that the infection level and growth of crop plants were positively correlated with the inoculated spores in both pure and mixed cropping systems. (r =1.000 and 0.997 significant at 1 % and 5 % respectively).

References

Abbott , L.K. and De Boer , G (1984) : The effect of phosphorus on the formation of hyphae on soil by the vesicular-arbuscular mycorrhizal fungus *Glomus fasciculatum*, New phytol , 97 , 437-446.

Abbott , L.K. and Robson , A.D. (1984) : The effect of VAM on plant growth In : VAM (Ed. Powell , C.L. and Bagyaraj , D.J.) CRC press , Florida , pp . 113-130.

Abbott , L.K.; Robson , A.D. and Jasper , D.A. (1989) : Hyphae of VAM fungus maintain infectivity in dry soil , except when the soil is disturbed. New phytol , 112, 101-107.

Agnew , M.L. ; Varrow , R.N. (1985) : Soil compaction and moisture stress preconditioning in kentucky blue grass I. Soil aeration , water use and root responses. Agronomy journal , 77 , 872-878.

Allen , S.E. (1974) : Chemical analysis of ecological materials , Blackwell scientific publications , (New Delhi)

Allen , M.F. (1982) : Influence of vesicular-arbuscular mycorrhizae on water movement through Bouteloua gracili . New phytol , 91, 191-196.

Asai , T. (1943) : Die Bedutung der mykorrhiza fur das pflanzenleben . Jap . J.Bot. , 12, 359-436.

Azcon , R. and Ocampo , J. A. (1981) : Factors affecting the vesicular-arbuscular infection and mycorrhizal dependency of thirteen wheat cultivars . New phytol , 87 , 677-685.

Bakshi , B.K. (1974) : Mycorrhiza and its role in forestry. P.L. 480. Project report , forest res , Inst. And colleges , Derhadun , India.

Baylis , G.T.S. (1970 and 1971) : Root hairs and phycomycetous mycorrhizae in phosphorus deficient soil. Plant and soil , 33 , 713-716.

Bethenfalvy , G.J. (1992) : Mycorrhizae and crop productivity In : Mycorrhizae in sustainable agriculture , American society of Agronomy . Spec. publ. No. 54 , 1-27.

Bengough , A.G. ; Mullins , C.E. (1991) : Penetrometer resistance , root penetration *resistance and root elongation rate in two sandy loam soils, plant and soil , 131 , 59-66.*

Bierman , B.J. and Linderman , R.G. (1981) : Quantifying vesicular-arbuscular mycorrhizae , a propesed method towards standardisation . New phytol.

Black , R.L.B. and Tinker , P.B. (1977) : Interaction between effects of vesicular-arbuscular mycorrhizas and fertilisers phosphorus on the fields of potatoes in the field. Nature (London) , 267 , 510-511.

Bolan , N.S. ; Robson , A.P and Barrow , N.J. (1987) : Effects of VAM on the availability of iron phosphate to plants . Plant and soil , 99 , 2-3.

Bomke , A.A. ; Berch , M.S. and Barbara , J. (1991) : Seasonal colonization of winter wheat in south coastal British columbia by VAM fungi. Can. J.Bot , 69 (1) , 78-86.

Braunberger , P.G. ; Abbott , L.K. and Robson , A.D. (1996) : Infectivity of AM fungi after wetting and drying , New phytol , 134 , 673-684.

Bruce , A ; Smith , S.E. and Tester , M (1994) : The development of mycorrhizal infection in cucumber : effects of P supply on root growth formation of entry points and growth of infection units , New phytol , 127 , 507-514.

Braundrett , M.C. and Kendrick , B (1989) : The mycorrhizal status , root anatomy , and phenology of plants in a sugar-maple forest. Can. J. Bot. 66 , 1153-1173.

Clarke , C.A. and Mosse , B. (1981) : Plant growth responses to vesicular-arbuscular mycorrhiza . XIII. Field inoculation responses of barley at two soil p levels. New phytol , 87 , 695-703.

Clapp , J.P. ; Young , J.P.W. and Fitter , A. (1995) : Diversity of fungal symbionts in VAM from a natural community , New phytol , 130 , 259-263.

Cooper , K.M. and Tinker , P.B. (1978) : Translocation and transfer of nutrients in vesicular-arbuscular mycorrhiza. II. Uptake and translocation of phosphorus , zinc and sulpher . New phytol , 81 , 43-52.

Cooper , K.M. and Tinker , P.B. (1980) : Translocation and transfer of nutrients in vesicular-arbuscular mycorrhizas . IV. The effect of environmental variables on movements of phosphorus (In prep.).

Crush , J.R. (1973) : Singificance of endomycorrhizas in tussock grassland in otago , New zea land .N.Z.J. Bot . , 11 , 645-660.

Daft , M.J. and Nicolson , T.H. (1972) : Effect of endogone mycorrhiza on plant growth IV. Quantitative relationship between the growth of the host and the develoment of the endophyte in tomato and maize . New phytol , 71 , 287-295.

Dalal , R.C. and Henderson , P.A. (1991) : Organic matter and microbial biomass in a vertisol after 20 years of zero-tillage , Soil. Biol. Biochem. 23 (5) , 435-441.

Declerck , S. ; Strulla , D.G. and Plenchette , C. (1998) : Monoxenic culture of the intraradical forms *Glomus sp.* Isolated from a tropical ecosystem : germplasm collection . Mycologia . 90 (4) . 579-585.

Deka , H.K. and Mishra , R.R. (1982) : Decomposition of Bamboo (*Dendrocalamus hamiltonii Ness.*) leaf litter in ralation to age of jhum fallows in North-East India. Plant and soil . 68 . 151-159.

Dhillon, S.S.(1992) : Host endophyte specificity of vesicular-arbuscular mycorrhizal colonization of *Oryza sativa L.* at the pre-transplant stage in low or high phosphorus soil. Soil. Biol.Biochem. 24 , 405-411.

Evans , D.G and Miller , M.H. (1988) : VAM and the disturbance induced reduction of nutrients absorption in maize.L. Causal relations . New phytol . 110 , 67-74.

Fairchild , G.L. and Miller , M.H. (1989) : VAM and the soil disturbance induced reduction of nutrient absorption in maize II. Development of the effect , New phytol , 110 . 75-84.

Fontenia, S, Garcia-Romera , I ; and Ocampo , J. A. (1999): Negative influence of non-host plants on the colonization of *Pisum sativum* by the VAM fungus , *G.mosseae*. 31, 1591-1597.

Frank, A.B. (1985): Uber die anf wurzelsymbiose beruhende Ernahrung gewisser Baume durch unterir-dische pillllllze. Ber Dtsch. Bot Ges. 3, 128-145.

Furlan , V. and Bernier-Cardon , M (1989) : Effects of N,P and K on formation of endomycorrhizae , growth and mineral content of Onion . Plant and soil. 113, 167-174.

Gardes , M. and Dahlberg , A. (1995) : Mycorrhizal diversity in arctic and alpine tundra : an open question . New phytol. 133 , 147-157.

Galloud , I. (1905) : Etuds surles mycorrhizas endotropes . Rev. Gen. Bot. , 17 , 5-500.

Gianinazzi , P. and Gianinazzi , S. (1983) : The physiology of VAM roots. Plant and soil. , 71 , 197-209.

Giovannetti , M. and Mosse , B . (1980) : An evaluation of techniques for measuring VAM infection in roots. New phytol , 84 , 489-500.

Hattingh , M.J. ; Gray , L.E. and Gerdeman , J.W. (1973) : Uptake and translocation of 32 p labelled phosphate to onion roots by endomycorrhizal fungi. Soil.sci. . , 116 , 383-387.

Hayman , D.S (1970) : Endogone spore numbers in soil and VAM in wheat as influenced by season and soil treatment. Trans.Brit. Mycol. Soc. , 54 , 53-63.

Hayman , D.S. and Stovold , B (1979) : Improved growth of white clover in hill grass lands by mycorrhizal inoculation. Ann. Appl. Biol. 93, 141-148.

Hayman , D.S and Mosse , B . (1979) : Influence of soils and fertility of activity and survival of VAM fungi . Phytopathology , 72, 1119-1125.

Heap , A.J. and Newman , E.L. (1980) : The influence of VAM on phosphorus transfer between plants. New phytol. 85 , 173-179.

Hepper , C.M. and Warner , A. (1983) : Role of organic matter in growth of a VAM fungus in soil . Trans. Brit. Mycol. Soc. , 81 , 155-156.

Ho, I and Trappe , J.W. (1975) : Nitrate reducing capacity of twoVAM fungi. Mycologia, 67 , 886-888.

Hoffmann , L. and Jungk , A. (1995) : Growth and phosphorus supply of sugar beat as affected by soil compaction and water tension. Plant and soil. 176 , 15-25.

Ibijibijen, J. and Urquiga , S. (1997) : Effect of VAM fungi on growth , mineral nutrition and nitrogen fixation of 3 varities of commom beans (*Phaseolus vulgaris*) . New phytol , 134 , 353-360.

Iiag, L.L. ; Rosales , A.M. ; Elazegal , I.A. and Mew , T.W. (1987) Changes in the population of infective endomycorrhizal fungi in a rice-based cropping system . Plant and soil , 103-104: 67-73.

Jasper , D.A. ; Abbott , L.K. and Robson , A. D. (1989b) : Hyphae of a VAM fungus maintains infectivity in dry soil except when the soil is disturbed. New phytol. 112 , 101-107.

Jasper , D.A. ; Abbott , L.K. and Robson , A.D. (1989 c): Soil disturbance reduces the infectivity of external hyphae of VAM fungi. New phytol. 112 , 93-99.

Jensen , A. (1982) : Influence of four VAM fungi on nutrient uptake and growth in barley. New phytol. 90 (1-4) , 45-50.

Jensen , A. (1982) : Influence of four VAM fungi on nutrient uptake and growth in barley (*Hordeum vulgars*) . New phytol. 90 , 45-50.

Johansen , A. ; Finley , D.R. and Olsson , P.A. (1996) : Nitrogen metablism of external hyphae of the VAM fungus *G.intradices* , New phytol. 133, 705-712.

Jones, F.G.W. ; Larbey , D.W. and Parrot , D.M. (1978). The influence of soil structure and moisture on nematodes and microbes , . Soil. Biol. Biochem. 1, 153-165.

John Kennedy , Z and Rangarajan , M (2001) : Biomass production , root colonization by six VAM fungi in pappaya. Indian phytopath. 54(1) , 72-77.

Johnson , W.C. ; Copeland , P.J ; Crookston , R.K. and Pfllleger , F.L (1990) : Mycorrhizae possible explanation for yield decline with continious corn and soybeans. Agron. J.84 , 387-390.

Kellam , M.K. and Schenck , N. C. (1980) : Interactions between a VAM fungus and root knot nematode on soybean. Phytopathology , 79 , 293-296.

Kiliham , K. and Firestone , M.K. (1983) : VAM mediation of grass response to acidic and heavy metal deposition . Plant and soil. 72 , 39-48.

Khaliq , A. ; Gupta , M.L. and Kumar , S. (2001) : The effect of VAM fungi on growth of peppermint. Indian phytopath., 54(1) , 82-84.

Klopatek , L. ; Deban , L.F. and Klopatek , J.M. (1988) : Effects of simulated fire on VAM in pinyon- Juniper woodland soil.Plant soil, *109* , *245-249*.

Krishna,K.R and Bagyaraj , D.J (1982) : Interaction between a VAM fungi and *Streptomyces cinnamomeous* and their effects in finger millet. New phytol , 92(1-4) , 401-405.

Lozano –Ruiz , J.M. ; Azcon , R ; and Gomez , M. (1990): Effects of arbuscular-mycorrhizal *Glomus species* on drought tolerance. Physilogical and nutritional plant responses. Appl.Env.Microbiol. , 61 , 456-460.

Lozano-Ruiz , J.M. ; Azcon , R and Palma , J.M. (1996): Superoxide dismutase activity in arbuscular-mycorrhizal *Lactuca sativa* plants subjected to drought tress .New phytol , 134 (2) , 327-333.

Manjunath , A and Bagyaraj , D.J. (1981): Components of VAM inoculum and their affects on growth of Onion. New phytol.87, 355-358.

Mishra , R.R. (1979) : Distribution of endogonaceae in a subtropical humid forest of Meghalaya. Nat. Acad. Sci , (Special volume) , 61-66.

Mc.Millan , Ben , G. ; Juniper , S. and Abbott , L.K. (1998) : Inhibition of hyphal growth of a VAM fungus in soil containing sodium chloride limits the spread of infection from spores. Soil. Biol. Biochem. 30 (13) , 1639-1646.

Mc.Rillag , Allen , M.F. ; Klironomos , J.N. and Field , C.B. (1999) : VAM percent root infection and infection intensity of *Bromus hordeaceus* grown in elevated atmospeheric CO_2. Mycologia. 90 (3) , 199-205.

Miranda , J.C. ; Harris , P.J. and Wild , A. (1989): Effects of soil and plant phosphorus concentrations on VAM in sorghum plants. New phytol. 112, 405-410.

Merry weather , J.W. ; Fitter , A.H. (1995) : VAM and phosphorus as controlling factors in the life history of *Hyacinthoides non-scripta(L)* chouard ex Rothm. New phytol. 129 , 629-636.

Merrywether and Fitter , A.H. (1995): External hyphae of VAM fungi absorbs phosphate from the soil and translocate it to the host root effectively. New phytol. 63 283-289.

Mosse , B. (1973) : Advances in the study of VAM. IV. In soil gives additional phosphate , New phytol. 72 , 127-136.

Mc Gee P.A. ; Pattinson , G.S ; Heath ; R.A. (1997) : Survival of propagules of VAM fungi in soils in eastern Australia used to grow cotton. Ecology , 135 (4) , 773-780.

Mosse , B. (1953) : Fructifications of an endogone species causing endotrophic mycorrhiza in fruit plants. Ann. Bot . (London) , New series , 20 , 349-362.

Mosse, B. and Bowen , G.D. (1968). A key to recognition of some endogone spore types. Trans. Brit. Mycol. Soc. 51 , 469-483.

Mosse , B. and Hayman , D.S. (1971) : Plant growth responses to VAM II. In unsterilised field soils. New phytol.. , 70 , 29-34.

Mosse , B. (1986) : Mycorrhiza in sustainable agriculture. Bio. Agri. And Horti. , 3 143-152.

Nadian , H. ; Smith , S.E. ; Alston , A.M. and Murray , R.S. (1997) : Effect of soil compaction on plant growth phosphorus uptake and morphological characteristics of VAM colonization of *Trifolium subterraneum* , New phytol , 135 , 303-311.

Nicolson , T.H. (1967) : VAM a Universal plant symbiosis. Sci.Prog. Oxford. 55 . 561-581.

Ocampo , J.A. and Hayman , D.S. (1981) : Influence of plant interactions on VAM infections. II. Crop relations and residual effects of non-host plants. New phytol. 87 , 333-335.

O'Halloran , I.P. ; Kachanoski , R.G. and Stewart , J.W.B. (1985) : Spatial variability of soil p as influenced by soil texture and management. Can. J Soil. 65 , 425-487.

Omar , S.A. (1996) : Growth effects of VAM fungus *G.constrictum* on maize plants in pot trials. Current content , 39 (20) , 503-508.

Peacock , J.T. and Mc. Millan , C. (1975) : VAM infectivity in certain crops. New phytol 23 , 12-14.

Peyronel , B. (1923) : Fructification de endophyte a arbuscules at a vesicles des mycorrhizas endophytes. Bule. Soc. Mycol. Fr. , 39 , 119-126.

Peyronel , B. ; Fassi, B. ; Fontana , A. and Trappe , J.M. (1969) : Terminology of mycorrhizae. Mycologia, 61 , 410-411.

Pfeiffer , C.M. and Bloss , H.E.C. (1987) : Growth and nutrition of guayule (*Parthenium argentatum*) in a saline soil as influenced by VAM and phosphorus fertilization. New phytol. 108, 315-321.

Porter , W.M. (1979) : The most probable number method for enumerating infective propagules of VAM fungi in soil. Aust. Jl. of soil. Res. 17 , 515-519.

Powell , C.L.L. (1976b) : Development of mycorrhizal infections from endogone spores and infected root segments. Trans. Brit. Mycol. Soc. 66 , 439-445.

Powell , C.L. and Daniel , J. (1978) : Mycorrhizal fungi stimulate uptake of soluble and insoluble phosphate fertilizers from a phosphate deficient soil. New phytol. 80 , 251-253.

Powell , C.L. (1979) : Inoculation of white clover and ryegrass seed with mycorrhizal fungi. New phytol , 83 , 81-85.

Ravanskov , S. and Jakobsen , I . (1995) : Functional compatibility in VAM measured as hyphal p transport to the plant. New phytol. 129, 611-618.

Read , D.J. ; Koucheki , H.K. and Hodgson , J. (1976) : VAM in natural vegetation systems I. The occurrence of infection . New phytol. 77 , 641-653.

Rhodes , L.H. and Gerdeman , J.W. (1975) : Phosphate uptake zones of mycorrhizal and non-mycorrhizal onions. New phytol. 75 , 551-561.

Robertson , K. (1983) : Microbial biomass in relation to C and N mineralisation during soil incubations . Soil. Biol. Biochem. 201(3) , 281-286.

Rose , S.L. (1980) : Mycorrhizal associations of some actinomycete nodulated nitrogen-fixing plants. Can. J.Bot , 58 , 1449-1454.

Saif , S.R. (1984) : The influence of soil aeration on the efficiency of VAM II. soil CO_2 and growth and mineral uptake in mycorrhizal and non-mycorrhizal plants of *Eupatorium odoratum(L)* , *Guizotia abyssinica(L.f) cass* and *sorghum bicolor(L) monch* . New phytol. 96 (1-4) . 428-435

.Schenck , N.C. and Kinloch , R.A.C. (1980) : Incidence of mycorrhizal fingi on six field crops in monoculture on a newly cleared woodland site. Mycologia , 72 , 445-456.

Sininovitch , D. ; Cloutier , Y. (1983) : Drought and freezing tolerance and adaptation in plants : some evidence of near equivalences. Caryobiology , 20 , 487-503.

Singh , J.S. ; Raghubanshi , A.S. ; Singh R.S. ; Srivastava , S.C. (1989) : Microbial biomass acts as a source of plant nutrients in dry tropical forest and savanna. Nature , 338 , 499-500.

Sparling and Tinker (1978 a, b, & c).: Mycorrhizal infection in pennine grassland I. Level of infection in the field .Jl. Appl.Ecol., 15 , 943-964.

Staddon , P.L. and Fitter , A.H. (2001) : The differential vitality of intraradical mycorrhizal structure and its implications. Soil. Biol. Biochem., 33 , 129-132.

Smith , S.E. and Skipper , J.D. (1979) : Effect of early mycorrhizal infection on nodulation and nitrogen fixation in *Trifolium subterraneum L.* Aust. J. Plant. Physiol. , 6 , 305-316.

Smith , S.E and Caulson , J (1988): Effects of mycorrhizal infection on plant growth , Nitrogen and phosphorus nutrition in glass house grown *Allium cepa. L.* New phytol. 103 , 359-373.

Srivastava , S.C. and Singh , J.S. (1991) : Microbial C, N and P in dry tropical forest soils: effects of alternate land uses and nutrient flux. Soil. Biol. Biochem. 23 (2) , 117-124.

Sutton , J.C. and Barron , G.L. (1972) : Population dynamics of endogone spores in soil . Can. J, Bot . , 50 , 1909-1914.

Sutton , J.C. and Barron , G.L. (1979) : Population dynamics of endogone spores in soil. Can. J. Bot. 50 , 1909-1914.

Tarafdar , J.C. and Marschner , H. (1994) : Phosphate activity in the rhizosphere and hyphosphere of VAM wheat supplied with inorganic and organic phosphorus . Soil. Biol. Biochem. 26 (3) , 387-396.

Tinker , P.B (1975) : Effects of VAM on higher plants. Sympo. Soc. Expt. Bio. , 29 , 325-349.

Tinker , P.B. and Black , R. (1975) : The development of endomycorrhizal roots systems. New phytol. 83 , 401-403.

Tinker , P.B. and Gildon , A. (1983) : Interactions of VAM infections and heavy metals in plants II. the effects of infection on uptake of copper, New phytol. 95 (1-4) , 263-268.

Vierheilig , H. ; Garrido . J.M. ; Wyss , U. and Piche , Y. (2000) : Systematic suppression of mycorrhizal colonization by AM fungi . Soil. Biol. Biochem. 32 , 589-595.

Vilarino , A. and Arines , J. (1990) : An instrumental modification of Gerdemann and Nicolson method for extracting VAM fungal spores from soil samples. Plant and soil. 121 , 211- 215.

Wagner , S.C. ; Skipper , H.D. ; and Bridges , W.B. (2001) : Long term survival of *G. claroideum* propagules from soil pot cultures under simulated conditions . Mycologia , 93 (5) , 815-820.

Walkley , A. and Black , I.A. (1934) : An examination of the degiareff method for determining soil organic matter and proposed modification of the chromic acid titration method . Soil. Sci. 37 , 29-38.

Walker , C. and Rosendahl , S. (1993) : Earthworm also act as a good vector for dispersal of AM fungal spores from one place to another. Soil. Biol. Biochem. 134 , 116-119.

Walker , C. ; Lanfranco , L. ; Broome , A. ; Giovannetti , M. ; Rosendahl , S. and Dodd , J.C. (1996) : Inter and intraspecific variation within the morpholigically similar fungi *G.mossese* and *G. coronatum*. New phytol. 133 (91) , 113-122.

Whittingham , J. and Read , D.J. (1982) : VAM in natural vegetation systems . III Nutrient transfer between plants with mycorrhizal interconnections. New phytol . 90 , 277-284.

APPENDIX

Abbott, L.K. and Robson, A.D. (1989): Hyphae of VAM fungus maintains infectivity in dry soil , except when the soil is disturbed. New Phytol. 112: 101-107

Abbott, L.K. and Robson, A.D. (1991): External hyphae of VAM fungi associated with *Trifolium Subterraneum*. I. Spread of hyphae and phosphorus inflow into roots. New Phytol. 120 (In the press).

Anderson , R.C. ; Ebbens , B.C. and Liberta . A.E. (1986): Soil moisture influences colorization of Prairie cord grass (*Spartina pectinata Lind.*) by VAM fungi. 102 (1-4): 529-540.

Azcon, R..;Ocampo, J.A. and Barea, J.M. (1982): Comparative effects of foliaror soil applied nitrate on VAM infection in maize. New Phytol . 92: 553-559.

Bago, B. ; Vierbeilig, H. , Piche, Y. and Aguilar-Azcon, C. (1996): Nitrate depletion and pH changes mycelium of the VAM fungus *Glomus intraradices* grown in monoxenic culture. New Phytol. 133 : 273-280.

Bagyaraj, D.J. and Varma, A.(1996): Interaction between VAM fungi and plants. Their importance in sustainable agriculture in arid and semiarid tropics. Current Content. 27 (12): 119.

Baylis, G.T S. (1970): Root hairs and *Phycomycetous* mycorrhizas in phosphorus deficient soil. Plant and Soil . 23: 713-716.

Baylis, G.T.S. (1971): Fungi , phosphorus and the evolution of plant roots. Search . 3: 257-258.

Becker, E.M. (1996): Successive pot cultures reveal high species richness of VAM fungi in arid ecosystem. New Phytol. 74 (12): 1919-1929.

Biermann, B and Linderman, R.G.(1983): Use of VAM roots , intraradical vesicles, extraradical vesicles as inoculum. 95(1): 97-107.

Bhattarai , I.D (1983): Studies on the maize crop plants showed more infection rate in moreV strain conditions of Meghalaya. Department of Botany. N.E.H.U. Ph. D thesis . pp 76-79.

Bolan, N.S. and Robson, A.P. (1983): Plant and soil factors including mycorrhizal infec causing sigmoidal response of plants to applied phosphorus. Plant and Soil . 73: 187-202.

Brundrett, M.C., Piche,Y. and Peterson, R.L. (1989): The mycorrhizal status , root anatomy sugar-maple forest. Can. J. Bot . 76:1142-1163.

Calmer, J.A.; Capaccio, L.C.M.; Parish, G. and Tinker, P.B.(1983): Determination estimation of polyphosphatase in VAM . New Phytol. 80: 125-134.

Cooper, K.M. and Tinker, P.B. (1981): Translocation and transfer of nutrients in VAM. Effects of environmental variables on movement of phosphorus. New Phytol. 81: 327-339.

Davis , R.M. and Fucik , J.E. (1986): Effect of girdling Sour-orange seedlings on mycorrh development. Hort. Science. 21: 302-304.

De Boer, N.E. ; Hill, R.R., Pell, E.J. and Cole, R.H.(1982): Quantative inheritance of oz resistance in Potato. Crop Science. 22: 992-995.

Evans, D.G. and Miller, M.H. (1988): VAM and the soil disturbance induced reduction nutrient absorption in maize I. Causal relations. New Phytol. 110: 67-74

Francis, R. ; Finley , R.D. and Read, D.J. (1986): VAM in natural vegetation systems. Transfer of nutrients in inter and intra specific combinations of host plants. New Phytol. 1 103-111.

Gasper, J.P.; Linderman, R.P. and Menge, J.A. (1997): Development of external hyphae different isolates of mycorrhizal *Glomus sp.* in relation to root colonization. New Phytol. 186-189.

Gerdeman, J.W. and Nicholoson, T.H.(1963): Spores of mycorrhizal endogone species extracted from soil by wet sieving and decanting. Trans.Brit.Mycol.Soc. 46: 235-244.

Gianinazzi-Pearson (1984): Ultrastructure aspects of endomycorrhiza in the Ericaceae. IV. Comparision of infection by Pezizella ericae in host and non-host plants. 98 (1-4) : 329-334.

Gianinazzi-Pearson .V (1984): Host fungus specificity recognition and compatibility in mycorrhizae. Involved in microbe plant interaction (D.P.S. Verma and T. Hohn , Eds) pp. 225-253. Springer. Berlin.

Giovannetti, M. and Mosse, S. (1979): Enzymatic studies on the metabolism of VAM.II. soluble alkaline phosphatase specific to mycorrhizal infection in onion roots. Physiological Plant pathology.12: 65-73.

Hattingh, M. J. and Gerdeman, J.W. (1975): Inoculation of Brazilian sour orange seed with an endomycorrhizal fungus. Phytopathol.65: 1013-1016.

Hayman, D.S. and Mosse, B. (1972): Plant growth response to VAM III. Increased uptake of labile P from soil. New Phytol. 71: 41.

Hayman, D.S. ; Barea, J.M. and Azcon, R. (1976): VAM in Southern Spain: Its distribution in crops growing in soil of different fertility. Phytopathologica Mediterranea. 15: 1-6.

Heap, A.J. and Newman, E.J. (1979): The role of nitrate and phosphate on VAM infection of certain crops. New Phytol. 95: 489-500.

Hepper, C.M. (1983): The effect of nitrate and phosphate on the VAM infection of Lettuce (*Lactuca sativa cultivar ranate*). New Phytol. 93: 389-400.

Ibijibijen, J. ; Uruquiaga, S. ; Ismaili. M. ; Alves. B.J.R. ; Boddey, R.M. (1996): Effects of VAM fungi on growth , mineral nutrition and nitrogen fixation of 3 varities of common beans (*Phaseolus vulgaris*) . New Phytol.134: 353-360.

Iiag , L.L. ; Rosales , A.M. ; Elazegul , I.A and Mew , T.W. (1987): Changes in the population of infective endomycorrhizal fungi in a rice- based cropping system. Plant and Soil. 103-104: 67-73.

Philips, J.M. and Hayman , D.S. (1970): Improved procedure for clearing roots and staining parasitic VAM fungi for rapid assesment of infection. Trans. Brit. Mycol. Soc. 55: 158-161.

Jakobsen, I. and Anderson, J. (1981): The presence of VAM in Barley grown in some Danish soils with different fertilizer treatments. Plant and Soil.65: 303-315.

Jakobsen , I. Joner, E.J. and Larsen , J. (1994): Hyphal phosphorus transport , a keystone to mycorrhizal enhancement of plant growth. In: Gianinnazzi , S. Schuepp , H , eds. Impact of VAM on sustainable Agriculture and Natural Ecosystems. Basel / Switzerland. Birkhausev Verlag. 133-146.

Jasper, D.A. ; Abbott, L.K. and Robson, A.D. (1987): The effect of surface mining on the infectivity of VAM fungi. Austr. J. of Bot. 35: 641-652.

Jasper, D.A. ; Robson, A.D. and Abbott, L.K. (1991): The effect of soil disturbance on VAM fungi in soils from different vegetation types. New Phytol. 118 (3-4): 471-482.

Jensen , A.(1985): Evaluation of VAM as a parameter in Breeding field peas. Pajbjergfonden and the Danish Academy of Technical sciences.

Johnson, A. ; Jakobsen, I. and Jensen, E.S. (1993): External hyphae of VAM fungi associated with *Trifolium subterraneum L.* (Hyphal transport of ^{32}P and ^{15}N) . New Phytol. 124: 61-68.

Malcon, C. ; Greylong, M. and Gressel, J. (1989): Correlation between CuZn superoxide dismutase and glutathione reductase and environmental and xenobiotic stress tolerance in maize inbreeds. Plant Science. 69: 157-166.

Marinissen, J.C.Y. and Ruiter, P.C de. (1993): Contribution of earthworms to carbon and nitrogen cycling in agro-ecosystems. Agrl.Ecos.and Environ. 47: 59-74.

Mc Gee, P.A. ; Pattinson, G.S. ; Heath, R.A. ; Newman, C.A. and Allen, J. (1997) : Survival of propagules of VAM fungi in soils in eastern Australia used to grow cotton. New Phytol.135 (4): 773-780.

Mishra, R.R .; Sharma, G.D. and Gatphoh, A.R . (1980):Mycorrhizas in the ferns of North-eastern India.Proc .Ind. Nat. Sci. Acad. 46(13): 546-551.

Nadian, H.; Smith, S.E. ; Alston, A.M. and Murray, R.S. (1996): The effect of soil compaction on growth and P uptake by *Trifolium subetrraneum*: Interaction with mycorrhizal colonization. Plant and Soil. (in press).

Nagahashi, N.C. and Douds, D.D. (1997): Germination and hyphal growth of VAM fungi during and after storage in soil at five matric potentials. Soil.Biol.Biochem.33: 167-173.

Nicolson,T.H. (1959): Mycorrhizae in *Gramineae*. I. Vesicular-arbuscular endophytes with special reference to the external phase. Trans. Brit. Mycol. Soc. 42: 421-438.

Pfeiffer, P.E .; Becard, G .; Taylor, L.P. ; Douds, D.D. and Donor, L.W. (1989): Flavonoids are not necessary plant signal compounds in VAM . Current Content. 38: 331-336.

Ravanskov, S. and Jakobsen, I. (1995): Functional compatibility in arbuscular mycorrhizas measured as hyphal P transport to the plant. New Phytol.129: 611-618.

Reddell , P. and Spain , V. Alista (1991): Earthworm act as vectors of viable propagules of mycorrhizal fungi. Soil. Biol. Biochem. 23(8): 767-774.

Ride and Drysdale (1972): A rapid method for the chemical estimation of filamentous fungi in plant tissue. Physiol. Pl. Path. 2: 7-15.

Roger, T.K. (1989): Appropriate controls for VAM Research. New Phytol. 111(1), 35-44.

Rose, P. and Youngberg, T. (1989): Effect of VAM on growth nodulation and nitrogen fixation. Can. J. Bot . 69: 44-49.

Sahni, S. (1976): VAM in some Nigerian soils . The effect of *Gigaspora gigantea* on the growth of rice. New Phytol. 97: 673-674.

Sanders, F.E. ;Mosse, B. and Tinker, P.B. (1977): The development of endomycorrhizal root systems I. Spread of infection and growth promoting effects with four species of VA endophyte. New Phytol. 78: 257-268.

Schenck, N.C. and Smith, D. (1989): Relationship of colonization and sporulation by VAM fungi to plant nutrient and carbohydrate contents. New Phytol.116 (3-4): 621-627.

Scott, F.S. ; Smith, S.E. ; Smith, F.A. and Sukarno, N. (1996): The effect of fungicides on VAM symbiosis. II. The effects on area of interface and efficiency of P uptake and transfer to plant . New Phytol. 132 (4): 583-592.

Singh, R.S. ; Singh, J.S. and Srivastave, S.C. (1991): Nitrogen mineralisation in dry tropical Savanna: effects of burning and grazing. Soil. Biol. Biochem. 23(3): 269-273.

Skipper, H.D.and Smith,G.H.(1979): Influence of soil pH on the Soybean endomyycorrhiza. Plant and Soil. 53; 559-563.

Sparling, G.P. and Tinker, P.B. (1978 a) : Mycorrhizal infection in pennine grassland .I. Levels of infection in the field. J . Appl. Ecol. 15: 943-950.

Sparling , G.P. and Tinker, P.B. (1978b): Mycorrhizal infection in pennine grassland II. Effects of mycorrhizal infection on the growth of some upland grasses on γ-irradiated soils. J. Appl. Ecol. 15: 951-958.

Sparling, G.P. and Tinker, P.B. (1978c): Mycorrhizal infection in pennine grassland III. Effects of mycorrhizal infection in growth of white clover. J. Appl. Ecol. 15 : 959-964.

Sutton, J.C. (1973): Development of VAM in crop plants. Can. J. Bot. 51: 2487-2493.

Tinker ,P.B. (1975 a): the soil chemistry of phosphorus and mycorrhizal effects on plant growth. In Endomycorrhizas (Eds by F.E. sanders , B.Mosse and P.B.Tinker) pp. 253-272. Academic press. London.

Trappe,J M.and Schenck,N.C.(1984): Identification of VAM fungi. Methods in Mycorrhizal research.

Vogelzag, B .; Parsons, H. and Smith, S. (1993): Separate effects of high temperature on root growth of *Vigna Radiata. L.* and colonization by the VAM fungus *Glomus versiforme*. Soil. Biol. Biochem. 25: 1127-1129.

Walker, C. ; Mize, C.W. ; and Mc Nabb, H.S. (1982): Populations of endogonaceous fungi at two locations in central Iowa. Can. J. Bot. 60: 2518-2529. .

Wiermkan, A. ; Clapp , J.P. and Sanders, L.R. (1996): The genetic diversity of VAM fungi in natural ecosystems :- a key to understanding the ecology and functioning of the mycorrhizal symbiosis. New Phytol. 133(1): 123.

Zajicek, P.A .; Robson, D. and Kellam, S.N. (1987): Influence of drought stress and mycorrhizae on growth of two native forests. J. Amer. Soc. Hort. Sci. 112: 454-45

BIODATA

NAME : Sri Susant Kumar Parida.

ADDRESS: Present: - Department of Botany. North - Eastern Hill University.

Shillong- 793022. Meghalaya.

Permanent: - At- Bichana, P.O.: Nuapara, Via: Marshaghai, Dist:

Kendrapara, Orissa. Pin: 754213.

ACADEMIC RECORD: -

Exam Qualified	Year	Univ/Board	Class/Div
Matric	1985	H.S.C	First
+ 2 Science	1987	C.H.S.E..Orissa	Third
B. Sc (Hons)	1991	Utkal Univ	First
M.Sc	1994	N.E.H.U	First

RESEARCH EXPERIENCE :- 6 years on Mycorrhiza , Inoculum Production , Maintenance of Inoculum.