EFFECT OF VERMICOMPOST ENRICHED WITH MICROBIAL FERTILIZERS ON THE PRODUCTIVITY OF BRINJAL

MINOR RESEARCH PROJECT

REPORT

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*This is to certify that the Minor Research Project work entitled "**Effect of vermicompost enriched with microbial fertilizers on the productivity of Brinjal" (Ref.no.MRP(S)-994/10-11/KLM GO 31/UGC-SWRO KLM GO 31 Dated 22nd December 2010**) is a bonafide research work done in the **Dept of Zoology Baselius College**, **Kottayam** by **Dr. Susan Panicker, Associate Professor & HOD** of Zoology, as the **Principal Investigator and Ms.Nisha S Babu**, Research Scholar as **co investigator** during the period of July 2011 to March 2013.*

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EFFECT OF VERMICOMPOST ENRICHED WITH MICROBIAL FERTILIZERS ON THE PRODUCTIVITY OF BRINJAL

ABSTRACT

Earthworms are soil invertebrates that play a key role in recycling organic matter. Total microbial population of vermicompost produced by three earthworm species known as Eudrilus eugeniae, Eisenia foetida, and Perionyx excavates were studied. Aerobic and anaerobic bacterial count as well as fungal count of fresh and three week old vermicompost were examined. Fresh vermicompost contains more microorganisms than three weeks old vermicompost.

Vegetables are considered as protective foods which form an integral part of our diet. Brinjal (Solanum melongena L) otherwise called as aubergine, egg plant or guinea squash is one of the most common tropical fruit vegetables. Inadequate and imbalanced use of plant nutrient is one of the major constraints for low productivity of vegetables. The beneficial effect of vermicompost and microbial fertilizers improve soil fertility and productivity. The study throws light on the utility of some microbial inputs and technologies in supplying nutrients to the plants and protection from pathogens for achieving a more favourable environment for optimum crop production and protection. Pots containing vermicompost with Azospirillum and Phosphobacteria have better growth rate than the control pots.

Azospirillum species is an important microbial fertilizer being used in agriculture all over the world. Azospirillum sp. is an associative microaerophilic diazotroph isolated from the root and above ground parts of a variety of crop plants. Biofertilizers are inputs containing microorganisms which are capable of mobilizing nutritive elements from non usable form to usable. Treatment using vermicompost with Azospirillum showed better results compared to others.

Key Words: ***Azospirillum, Nitrogen fixation,biofertilizer, Vermicompost, Brinjal, Phosphobacteria***

1. INTRODUCTION

THE EFFECT OF VERMICOMPOST ENRICHED WITH MICROBIAL FERTILIZERS ON THE PRODUCTIVITY OF BRINJAL

1.1 INTRODUCTION

Brinjal is one of the most commonly grown vegetable crops in India. Brinjal belongs to the family *Solanaceae*. The world scenario indicates that India is the second largest producers of vegetables after China. Inadequate and imbalanced use of plant nutrients is one of the major constraints for low productivity of vegetables. The beneficial effect of vermicompost, an organic manure in improving soil fertility and productivity is well documented (Bano *et al.* 1987). With the indiscriminate use of fertilizers and chemicals there is increasing risk of health hazards. Continuous use of chemical fertilizers has resulted in the depletion of soil health. Thus there is an urgent need to generate organic farming practices using compost, vermicompost and microbial fertilizers etc.

Biofertilizers are products containing living cells of different types of microorganisms that have an ability to mobilize nutrients from unusable form through biological process and these groups of microorganisms may either fix atmospheric nitrogen or solubilise insoluble phosphorus and make them available for crops. *Azospirillum, Phosphobacteria, VAM, Azetobacter, Rhizobium* etc., are the main types of organisms widely recommended for many field crops.

Biofertilizers were found to have positive contribution to soil fertility resulting in an increase in crop yield without causing any type of environmental wastes or soil hazards. Significant improvement in growth and yield and quality of vegetables with different biofertilizer applications have been reported on various crop. In this study two types of microbial fertilizers were used, that is *Azospirillum* and *Phosphobacteria.* Azospirilum species are important microbial fertilizers using in agriculture all over the world. *Azospirillum* is an associative microaerophilic diazotroph isolated from the root and above ground parts of a variety of crop plants. Biofertilisers are inputs containing microorganisms which are capable of mobilizing nutritive elements from non usable form to usable. In this study the

importance of *Azospirillum* species in agriculture was examined. Pot culture experiments using *Azospirillum* and controls (soil and vermicompost) was done. Treatments using *Azospirillum* shows better results compared to others.

Azospirillum is a plant growth promoting bacterium, which lives in close association with the roots of many cultivated plants. *Azospirillum* enhance acetylene reduction activity, an assay used to estimate nitrogenase activity (Burdman *et al* 1997) and plant growth (Burdman *et al,1997* Kundu *et al* 1993, Neyra *et al* 1995) in dry bean. *Azosprillum*, an associate nitrogen fixer, fixes atmospheric nitrogen on the root surface which is taken up by the plants, it secretes growth hormones, which enhances root development. *Azospirillum* are widely distributed in soil and are associated with the roots of forage grasses, cereals and non gramineous plants (Bashan Y, Holguin G 1997) Nitrogen fixation by *Azospirillum* has been of interest for many years, beneficial responses of crops to inoculation with this bacterium have been reported (Bashan Y, Levanony H 1990).

Consumers interest in healthy and safe food and in environmental concerns has been increasing recently . The definition of quality product has been changing and in addition to the nutritional and health characteristic of food products, environmental protection has been emphasized, giving to the product itself a new attribution of a so called “environmental quality” (Cornevale) 2000.

Composting is an environmentally sound and agronomically advantageous way to utilize organic wastes for soil organic amendment at an acceptable operational cost. It involves complete or partial degradation of a variety of chemical compounds by a consortium of microorganisms. The biological decomposition of organisms is mediated by a variety of biochemical processes in which enzymes lay a key role (Garciac *et al.* 1972, Wollur 1982). The degradation of major constituents like cellulose, hemicelluloses, lignine, starch and different protein compounds present in waste is carried out by specific enzymes. Therefore, the qualification of enzyme activity during composting can reflect the dynamics of composting process in terms of decomposition of organic matter and nitrogen transformation. It may also be helpful in providing information about the maturity of the composted product.

Composting is the natural process of rotting or decomposition of organic matter by microorganisms under controlled conditions. Compost is a rich source of organic matter. Soil organic matter plays an important role in sustaining soil fertility and hence in sustainable agricultural production.

Composting may be divided into two categories by the nature of the decomposition process; Aerobic composting and anaerobic composting. In anaerobic composting, decomposition occurs where oxygen is absent or in limited supply. Under this method anaerobic microorganisms dominate and develop intermediate compounds including methane, organic acids, hydrogen sulphide and other substances. In the absence of oxygen these compounds accumulate and are not metabolized further, as anaerobic composting is a low temperature process. Aerobic composting takes place in the presence of oxygen. In this process aerobic microorganisms break down organic matters and produce carbon dioxide, ammonia, water, heat and humus. Anaerobic composting may produce intermediate compounds such as organic acids. Aerobic microorganisms decompose them further. The heat generated accelerates the breakdown of proteins, fats and complex carbohydrates such as cellulose and hemicelluloses. Hence the processing time is shorter. Composting objectives may also be achieved through the enzymatic degradation of organic materials as they pass through the digestive system of earthworms. This is termed vermicomposting. Factors influencing composting are moisture, nutrients, temperature, p^H value etc.

Moisture is necessary to support the metabolic activity of the microorganisms. Microorganisms require carbon, nitrogen, phosphorous and potassium as primary nutrients. The precompost is used as a feed for earth worms. Parle (1963) reported that most of the cellulose and chitinase enzyme that occur in the intestinal canal of earthworms are secreted by the earthworms and not by symbiotic microorganisms. From an indigenous gut microflora, there was a great increase in the total number of bacterial and actinomycetes occurring in the earthworm gut compared with those in the surrounding soil and other workers showed that the numbers increase exponentially from the anterior to posterior portions of the earthworm gut (Parle 1963). More than 50 species of bacteria have been reported to be isolated from the intestinal canal of earthworm and found none that differ from those in the soil from which the earthworms had been taken.

Baro's and Hardle (1986) showed that the intestinal mucous produced by earthworm contained large amount of water soluble, low molecular weight organic compounds that could be assimilated easily by the rapidly multiplying microbial community in the gut. Active phase of vermicomposting is characterized by mesophilic bacteria and fungi which are stimulated and encouraged by the activity of earthworms (Subler *et al* 1998)

The importance of earthworms for plant growth has recognized for over hundred years since the publication of Charles Darwin's book "The formation of vegetable mould through the action of worms" in 1881.Vermicompost promote the growth of a wide range of cereals, vegetables, ornamental plants etc.(Kale *et al* 1992,Edwards and Neuhauser 1988) Among the various crops grown in our country, solanaceous vegetables play an important role in nutrition. Brinjal *(Solanum melongens L.)* otherwise called as Dubergine, eggplant, garden egg or guinea squash is one of the most common tropical fruit vegetable.

In order to increase the fertility status of the vermicompost produced by the earthworm species, nitrogen fixing bacteria of the species *Azospirillum* and the phosphorous solubilising microorganisms were inoculated in the vermicompost produced from weeds cowdung compost. The incorporation of vermicompost along with microbial fertilizers had beneficial effect on the crop yield. The beneficial effect of vermicompost as organic manure in improving soil fertility and productivity is well documented (Bano *et al* 1987). With the indiscriminate use of fertilizers and chemicals there is increase in the risk of health hazards. Continuous use of chemical fertilizers has resulted in the depletion of soil health. Thus there is an urgent need to generate organic farming practices using compost, vermicompost and microbial fertilizers.

Microbial fertilizers are products containing living cells of different types of microorganisms that have an ability to mobilize nutrients from unusable form through biological process and these groups of microorganisms may either fix atmospheric nitrogen or solubilise insoluble phosphorus and make them available for crops.

Azospirillum, Phosphobacteria, VAM, Azotobacter, Rhizobium etc are the main types of organisms widely recommended for many field crops. Microbial fertilizers or biofertilizers were found to have positive contribution to soil fertility resulting in an increase in crop yield without causing any type of environmental

wastes or soil hazards. Significant improvement in growth and yield and quality of vegetables with different biofertilizer application has been reported in various crops. In this study two types of microbial fertilizers are used *Azospirillum and Phosphobacter.*

Azospirillum is a plant growth promoting bacterium, which lives in close association with the roots of many cultivated plants. Azospirillum enhance acetylene reduction activity and plant growth (Burdman *et al* Kundu *et al* 1993, Weyra *et al* 1995) in dry bean. *Azospirillum* an associate nitrogen fixer, fixes atmospheric nitrogen on the root surface which is taken up by the plants, it secretes growth hormones which enhances root development. Nitrogen is an essential component of all life forms. Phosphorus is the second major nutrient for plants. Phosphorus exist in nature in a variety of organic and inorganic forms which are insoluble to very poorly soluble. Phosphate solublising bacteria have the ability to solubilise insoluble mineral phosphate by producing various organic acids, sclerophores, mineral acids, protons, humic substances etc. Phosphorus solubilising microorganisms solubilise different forms of insoluble phosphate by producing either chelating organic acid such as citric acid, succinic acid, fumaric acid and malic acid or even mineral acids such as sulphuric acid and nitric acid.Phosphorus solubilising micro organisms include different groups of soil micro organisms. Some of the important organisms are *Bacillus megatherium, Pseudomonas liquifacians, Var.phosphaticum, Bacillus polymyxa, Pseudomonas striata, Agrobacterium, Aspergillus fumigates, Aspergillus niger, Penicillium digitatum etc*. These efficient micro organisms have the capacity to solubilise phosphorus content supplied through fertilizer application in soil.To improve the productivity, balanced plant nutrition has an imminent role for which use of organic source and nutrition can be an option. The investigation attempts to throw light on the utility of some microbial inputs and technologies in supplying nutrients to the plants and protection from pathogens for achieving a more favourable environment for optimum crop production and protection.

Keeping the above facts in mind, the present investigation was taken up to 'The effect of vermicompost enriched with microbial fertilizers on the productivity of Brinjal.' The scientific information on these aspects in vegetables especially brinjal is very scanty.

To make up this lacunae the present investigation was taken with the following objectives.

1.2 Objectives of the study

1. ***To assess the effect of vermicompost and microbial inoculants on growth, yield and quality of brinjal.***
2. ***To assess the effect of vermicompost and microbial inoculants on the physical and chemical properties of the soil.***
3. ***To work out the economics of using vermicompost and different microbial inoculants.***
4. ***To make a suitable recommendation for the production of brinjal***

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2. REVIEW OF LITERATURE

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2.1 Vermicompost

Earthworms are the silent scavengers of earth. They convert all types of biodegradable organic matter and convert them in to a good growth medium for plants. The beneficial effect of vermicompost, an organic manure in improving soil fertility and productivity is well documented (Bano *et al* 1998). Earthworms are important drivers of soil biogeochemical process as they modify soil physicochemical properties and microbial communities by feeding, burrowing and casting activities. The stimulation of microbial activity by earthworm has been related to diverse earthworm derived processes such as alteration of soil physical structure, increase of surface attack by microorganisms through contamination of organic matter, production of mucus, and excreting substances such as urea and ammonia which constitute an easily assimilable pool of nutrients for microorganisms (Edwards and Neuhauser 1988).

Vermicompost involves biooxidation and stabilization of organic material through the interactions between earthworms and microorganisms. Although microorganisms are mainly responsible for the biochemical degradation of organic matter, earthworms play an important role in the process by fragmenting and conditioning the substrate, increasing surface area for growth of microorganisms and altering its biological activity (Dominguez 2004; Dominguez and Edwards 2004). During Vermicomposting process, when organic matter passes through the earthworm gut, it undergoes physical, chemical and biochemical changes by the combined effect of earthworm and microbial enzymatic activities. The role of microbes in the gut as well as in the cast is very essential for the degradation of organic wastes and release of nutrients to plants. (Flack and Hartenstein, 1984). One among the objectives of the study was to isolate and identify microorganisms from vermicompost produced by three different earthworm species.

2.1.1Effect on growth characters

Kale *et al,* (1987) found that worm cast when used as manure in place of FYM, significantly influenced vegetative and flowering characters. Shuxin *et al* (1991) obtained 30-50% increase in plant height, tillering, and cane diameter in sugarcane as a result of vermicompost application. They also reported 25% increase in height in soyabean plants with the use of vermicompost. Vadiraj *et al* (1993) observed that the use of vermicompost as a component of potting mixture in cardamom nursery helped in seedling growth and dry matter production in a short span of time. Krishnakumar *et al* (1994) reported better growth and developments of seedlings in cardamom nursery by the use of vermicompost in potting medium. The effect of vermicompost in turmeric was studied by Vadiraj *et al*(1993.The organic manures as well as biofertilizers greatly influence the growth of plants and thereby various physiological parameters. The influence of organic manures on leaf number LAI, DMP, was superior over inorganic fertilizer application (Subbarao and Ravisankar 2001). Similar results were obtained by Kuppuswami *et al*(1992). The integrated nutrient management studies in Chilli revealed highest RGR,CGR and NAR for vermicompost applied pots(Sharu,2002).

2.1.2Effect on yield

Vermicompost is a potential organic manure and is a rich source of major and minor nutrients to plants. According to Phule *et al* (1993) application of vermicompost in sugarcane resulted in significantly higher yield. Dharmalingam *et al* 1995 studied the effect of vermicompost pellected soyabean seeds and reported 16% increase in yield over non pellected seeds. Rajalakshmi *et al* (1997) in their studies on various organic manures in combination with chemical fertilizer NPK at 75:40:25 kg ha^{-1}, on chillies found that the yield was highest (8.36 ha^{-1}) in the treatment receiving vermicompost +NPK fertilizers and the lowest in vermiculture alone. Among the various organic manures, incorporation of vermicompost was considered as the best in improving all the characters

2.1.3 Effect on quality aspects

Increase of ascorbic acid content in tomato, pyruvic acid in onion and minerals in guards were reported by the application of organic manures (Rani *et al* 1997). According to Arun Kumar (2000) quality of Amaranthus like vitamin C, fibre and protein content improved with various organic manures. Vermicompost applied alone or in combination with organic and inorganic fertilizers resulted in better yield and quality of different crops (Gavrilov 1962, , Bano *et al* 1987). Considerable scientific data were generated to testify that the product obtained with the use of vermicompost is nutritionally superior, with good taste and, has good texture and have better keeping qualities (Lampkin, 1990). In sugar cane the quality of product was increased when vermicompost was adopted. Vermicompost has a definite advantage over other organic manures in respect of quality and shelf life to the products

2.2 Microbial inoculants.

Great emphasis has been laid on development and use of microbial fertilizers during the last two decades. Microbial fertilizers save N/P requirement up to 50% in most of the vegetable crops and increase the yield by 18 to 50% in different vegetable crops.

2.2.1Vesicular Arbuscular Mycorrhizae

Vesicular arbuscular micorrhizae, a bioagent are the most ubiquitous fungi which is able to take up, accumulate and transfer larger amount of phosphate to the plant by releasing the nutrients in the root cell containing arbuscles, which draw phosphate more efficiently from the soluble pool than non mycorrhizal plants. In addition mycorrhizal plants have shown greater tolerance to toxic heavy metals, drought, high soil temperatures, saline soils, adverse pH, transplant shocks and root pathogen, especially nematodes and pathogenic soil fungi than non mycorrhizal plants.

2.2.2. Effect on growth characters

VAM increase the rate of growth of plants and also influence the partitioning of phytomass between shoot and root (Smith, 1980). Relatively less of the photosynthetase are allocated to the roots and hence the root shoot ratio is usually lower in VAM plants than in non mycorrhizal counter part. Lower root: shoot ratio with VAM colonization have been reported by Puccini *et al* (1988). The root colonization by VAM fungi enhanced the growth, number of branches and fresh biomass yield of the periwinkle in comparison to non inoculated control plants. Maximum enhancement in biomass yield was shown by *Glomus mosseae* (33%). Higher root colonization seems to be a reflection of increased biomass yield of periwinkle plants (Gupta *et al* 2003). Thomas and Ghai (1988) observed an increase in plant height, number of leaves and shoot dry weight of pepper, Panniyur 1 on inoculation with different AMF. Barea and Azcon (1982) found that mycorrhizal fungi are capable of elaborating small quantities of growth hormones including auxins, which may help in inducing root production.

2.2.3 Effect on yield

The yield of peppermint was found to be significantly increased compared to control through inoculation of VAM fungi (Khalia *et al* 2001). Experiments were conducted on *Azotobacter and Azospirillum* alone and their combined effect with VAM and it was found that combined application of *Azotobacter* and nitrogen application increased yield by 18% more than applying nitrogen fertilizer alone. In another trial combined application of *Azospirillum and VAM* increased yields by 18.3% as well as saved 25% of inorganic fertilizers and there by reduced cost of cultivation in onion. In the case of chilli plants inoculated with mycorhizae biofertilizer resulted in more number of fruit and fruit yield as compared to uninoculated plants.

2.2.4 Effect on quality aspects

Green chillies having higher ascorbic acid content were obtained when plants were inoculated with AMF (Bagyaraj and Sreeramalu 1982). The quality attribute of tomato mainly vitamin C content and TSS significantly increased on control plants by AMF inoculation (Surendra and Arangarasan 1995). AMF inoculated aromatic crops like cympobogon *Martini varmatia* or cympopogon winter *Janus jowitt* have more essential oil than in the control plants (Ratti and Genardhanan 1996,Ratti *et al* 2002).

2.2.5 *Azospirillum*

Biofertilizers were found to have positive contribution to soil fertility resulting in an increase in crop yield without causing any type of environmental, water or soil hazard. Significant improvement in growth, yield and quality of vegetables with respect of *Azospirillum a*pplication has been reported in various crops. Over the past 20 years in the case of 60-70% of the experiment done world wide, an increase in yield due to *Azospirillum* inoculation could be observed.

2.2.6 Effect on growth characters

According to Smith *et al* (1978), *Azospirillum* inoculation resulted in the increased root and shoot growth and biomass accumulation of crop plants. *Azospirillum* has the ability for better root induction in inoculated plants mainly due to the production of plant growth hormones like IAA and Ga. As a result of this such plants are capable of absorbing more and more available nutrients from the soil which in turn results better establishment of plant seedlings and subsequent growth (Tien *et al* 1979, Govindan and Purushothaman 1989). Manib *et al* 1979 reported increased dry weight of tomato plants by 5-12% due to inoculation of *Azospirillum*. Kapulnic *et al* (1981) studied the effect of *Azospirillum* inoculation on wheat, *Sorghum* and observed that inoculation with *A.brazilience* resulted in significant increase in plant height in all the three crops. Use of *Azospirillum* alone

produced better growth response equivalent to that of 30kg N ha^{-1}in rise (Prasad and Singh 1984). There was significant increase in root length (3.5%), root dry weight (50%) and total leaf area of 18 days old tomato seedling due to *Azospirillum* inoculation (Okon 1987). In *Azospirillum* treated brinjal seedlings, the plant height was significantly increased from 11.2 to 15.3 mm as compared to uninoculated treatment (Parvatham *et al* 1989). Dhanalekshmi and Pappiah 1995 reported that the *Azospirillum* treated tomato seed have the highest germination percentage, shoot and root length, fresh and dry weight of seedling, number of primary, secondary roots and better rate establishment. Increased plant height, number of primary branches per plant, and number of lateral roots in chilli were noticed when inoculated with *Azospirillum* (Paramaguru and Nadaraja 1993). RajeshKumar *et al (*1995) got better yielding in Bhindi when plants were treated with *Azospirillum,* FYM and inorganic fertilizers.

2.2.7 Effect on yield

Cohen *et al* (1980) obtained increased yield for a wide range of tropical and temperate crops by *Azospirillum* inoculation. The mechanism by which the plant inoculated with *Azospirillum* and *Azotobacter* derive positive benefits in terms of increased grain yield, plant biomass and N uptake are attributed to small increase in nitrogen input from BNR, development and branching of roots, production of plant growth hormones, enhancement on uptake of NO_3, NH_4, H_2SO_4, K^+, Pb^+ and Fe^{2+}, improved water status of plants, increased nitrate reductase activity in plants, production of anti bacterial and antifungal compound (Okaon 1985 Pandey and Kumar 1989, Nani 1990). *Azospirillum* inoculation was known to increase the yield of crop by 5 to 20 % with savings of 40%of the recommended dose of nitrogen, Dart (1986). Amrithalingam (1988) observed in earliness in first flower appearance and 50% flowering by *Azospirillum* treatment. The treatment increased the number of flowers, fruits, plant fresh and dry weight of pod, plant length and girth, number of seeds and weight of seed per pod. Okon and Gonzalez (1994) by evaluating world wide data over the past 20 years on yield inoculation experiment with *Azospirillum* concluded that these bacteria are capable of promoting the yield of agriculturally important crops in

different soils in various climatic regions. The result showed significant increase in yield in the order of 5 to 30%. Studies on the effects of N & P with *Azospirillum* and *Phosphobacteria* in pumkin revealed that application of 9Kg N and 18Kg P/ ha along with biofertilizers recorded the highest fruit yield of 16.9 and 17.79 Kg / plant as against 9.49 and 8.8Kg at the recommended dose of 12Kg N and 24Kg P respectively. Karuthamani *et al* (1995). Dhanalakshmi and Pappiah (1995) reported that *Azospirillum* treated tomato plants showed early flowering to the extent of 5 days with highest number of flowers, fruit set and maximum yield as compared to uninoculated plants.Zachariah (1995) showed that application of *Eudrilus* compost enriched with both *Azospirillum* and solubilising organism to plants gave maximum per plant yield in chillies.

2.2.7 Effect on quality

Inoculation with *Azospirillum* increased capsaicin and ascorbic acid contents in chilli (Balakrishnan 1988), Azospirilum has been reported to significantly increased the growth, yield, nutrient uptake, dry matter and vitamin C contents in cabbage, cauliflower and tomato. (Subbiah 1990, reported that *Azospirillum* treated tomato plants gave fruits with high TSS (8.467)) and acetic acid (329/mg 100^{-1}). Increased protein content when wheat inoculated with *Azotobacter* and *Azospirillum* was reported and *Azospirillum* treatment recorded the increase in height, ascorbic acid and capsaicin content (Amrithalingam 1988). Chatto *et al* (1997) observed that in knol-knol *Azospirillum* increased yield and quality attribute over control. There was a significant increase in dry matter and vitamin C over control.

2.3 BRINJAL

Brinjal or egg plant (*Solanum melongena* L) is an important solanaceous vegetable crop grown in India and throughout the world. It has been one of the vegetables in our diet since ancient times. Brinjal is a warm season fruit vegetable susceptible to frost. It is highly productive and rated as poor man vegetable. It has much potential raw material in pickle making, dehydration industries (Singh *et al* 2000). Besides its use as fresh vegetable, it is known to

have some medicinal properties in curing diabetic patients. India is the primary centre of origin of this crops .It is a transplanted vegetable and flowers generally emerged 40 to 45 days after transplanting.

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3. MATERIALS AND METHODS

3. MATERIALS AND METHODS

The study was conducted at the microbial inoculant research lab of Department of Zoology, Baselius College Kottayam during 2011-2012. The soil of the experiment belongs to sandy loam in texture and acidic in reaction.

3.1. PREPARATION OF VERMICOMPOST

Vermicompost was prepared by using different species of earthworms with banana waste and cowdung as substrate

3.1.1 Earthworm species

Three earthworm species were used for this study

1) *Eisenia foetidae*

2) *Eudrilus eugeniae*

3) *Perionyx excavates*

Earthworm species were obtained from a commercial supplier in Kottayam. Earthworms of all three species were cultivated in the laboratory using cowdung as breeding medium for three months before the start of experiments.

Preparation of vermicompost

a) Treatment structure

No. of treatments: 9

No.of replication: 3

Substrate used: Banana wastes and weeds

Treatment 1	*E.eugeniae* + Banana wastes
Treatment 2	*E.foetidae* + Banana wastes
Treatment 3	*P.excavatus* + Banana wastes
Treatment 4	*E.eugenia* + weeds
Treatment 5	*E.foetidae* + weeds
Treatment 6	*P.excavatus* + weeds
Treatment 7	*E.eugeniae* + cowdung
Treatment 8	*E.foetidae* + cowdung
Treatment 9	*P.excavatus* + cowdung

The vermibeds were prepared in plastic troughs of 12''x 17''x 91in triplicate with weeds and banana wastes with cow dung in ratio 5:1. Twenty numbers of the earthworm species *Eudrilus eugeniae. Eisenia foetidae, and Perionyx excavates each* were introduced manually in to set of troughs. Control was maintained without weed and banana wastes. Watering was done regularly. The vermibed mixtures were mixed carefully once in a week without damaging the worms. Vermicompost was collected from the vermibeds for microbial examination.

3.1.2 Microbiological examination of vermicompost

Vermicasts were collected (fresh and after 3 weeks) and stored at ambient temperature. All samples were collected in triplicates using sterilized polythene bags. Serial dilutions of vermicast samples were prepared, from each dilution 0.1 ml of sample was inoculated in to appropriate media for the isolation of microorganisms. Sabarouds dextrose agar supplemented with 0.01% Streptomycin sulphate were used for isolation and enumeration of fungi. Mac Conkey agar and Nutrient agar was used for isolation of bacteria and Nutrient agar was used for total viable count of bacteria.

3.2 Experimental Material - Brinjal

The brinjal variety 'Haritha' was used for the experiment. This variety is resistant to bacterial wilt and is high yielding with long green coloured fruits. Seeds were collected from Regional Agricultural Research Station, Kumarakam, Kottayam.

3.3Manures and fertilizers

The manures used were vermicompost with microbial fertilizers such as *Azospirillum* and VAM. For controls chemical fertilizers such as Urea, Factamphos and muriate of potash.

3.4 Experimental Method

Experiment was conducted in a completely randomised block design. 39 days old seedlings were transplanted into pots (29x27 cm) containing sand, soil and vermicompost in the ratio of 1Kg+4Kg+3Kg. Each plant was transplanted in to the respective pot as per the experiment. All the plants were given water daily for two weeks and after that irrigated on alternate days. The initial pH of the soil was 6.65. Before transplanting the shoot length, root length, and number of leaves of the seedling were recorded. Twenty four pots were selected for pot culture experiments. The 24 pots were arranged in three rows. About 20 g of *Azospirillum* species were added to the treatment T and 20 g of VAM were added to T5 and 10g A10 + 10gm VAM were added to T6, T7 and T8. The pots were placed above the bricks to drain the water properly. Microbial fertilizers were collected from RARS Kumarakam, Kottayam.

3.5 Seed treatment and germination

Seed treatment and germination were carried out as per the procedure outlined by Dr. Clarson 2003. Before sowing, seeds were treated with *Pseudomonas fluorescene* and *Trichoderma* for the protection of plants from all casualties.

3.6 Prevention of pest infection

200gm of garlic was ground, added four litres of water and the mixture was sprayed on to plants to prevent the pest infection.

3.7 Experimental Structure

No.of treatments – 8
No.of replication – 3
Design – CRD (Completely Randomised Design)

No.of pots – 24

Period of pot culture – 10 months.

3.8 Treatment structure

Treatment

1. Soil+*Solanum melongena* L
2. T1+VC+*Solanum melongena* L
3. T1+NPK+*Solanum melongena* L
4. T2+AZO+*Solanum melongena* L
5. T2+VAM+*Solanum melongena* L
6. T2+AZO+VAM+*Solanum melongena* L
7. T1+AZO+VAM+*Solanum melongena* L
8. T3+AZO+VAM+*Solanum melongena* L

The 8 pots in the 1st row were labeled as R1T1-R1T8 and in the 2nd row as R2T1-R2T8 and 3rd row as R3T1-R3T8

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3.9 Growth characters were analysed

3.9.1 Height of the plant

Height of the plant were examined at the time of transplantation and different intervals.

3.9.2 Number of branches per plant

The total number of branches in each treatment were counted at the maximum growth stage and then the average was taken.

3.9.3 Number of leaves per plant

Number of leaves of each treatment was counted at different intervals and the mean number of leaves per plant was worked out.

3.9.4 Leaf area index

From each treatment maximum length and breadth of leaves from all plants were recorded separately and leaf area was computed based on length-breadth method, using the following equation (Ancy 1992).

3.9.5 Length of the root

Root length of each treatment were recorded after harvest.

3.9.6 Total plant biomass

Shoot length, root length, no.of branches, no.of leaves, no.of fruits, no.of flowers etc were recorded at the time of harvest. The roots were washed gently with water to remove soil. The plants were separated to stem, side branches, roots and leaves. They were then dried in hot air oven at 70^{o}C (+ or – 2) till constant weight was obtained. Then weighted separately after cooling and total biomass content were determined and were expressed in grams.

3.10 Yield attributing characters

3.10 .1 No.of fruits per plant

Total no.of fruits from each treatment was counted and then average was calculated to get no.of fruits per plant.

3.10.2 Yield per plant

Weight of fruits per plant was recorded in after each harvest and the average was calculated to get the fruit yield per plant.

3.10.3 Harvest index

The harvest index was worked out from the data on total dry matter production and fruit yield as follows.

$$\text{Harvest index} = \frac{\text{Total fruit biomass}}{\text{Total plant biomass}} \times 100$$

3.10.4 Number of harvest

Total no.of harvest for each treatment was recorded.

3.10.5 Storage of fruits

Storage capacity of each fruit was recorded.

3.11 Quality attributes

3.11.1 Estimation of total protein content

Lowry's method developed by Lowry *et al* (1951) was adopted for the estimation of protein.

3.11.2 Estimation of proline content

Proline content in Brinjal were estimated according to the procedure of Bates *et al (*1973)

3.11.3 Estimation of indole acetic acid in Brinjal

Indole acetic acid content in brinjal was estimated by the procedure of Tien *et al* (1979)

3.11.4 Analysis of total nutrient content of plant material

Total nitrogen content in plant samples were analysed by micro-kjedhol's procedure suggested by Humphries (1956).

Total phosphorus content in plant material was analysed by the Vanadomolybdate phosphorous yellow colour method proposed by Jackson (1975).

Total potassium content of plant material was obtained by the procedure outlined by Jackson (1975).

3.12 POT CULTURE EXPERIMENTS

Another set of pot culture experiments were conducted to determine the effect of the biofertiliser *Azospirillum* alone on *Solanum melongena* L(Brinjal).The details of the experiments was as follows.

The study were conducted Baselius College, Kottayam. Seeds of brinjal were collected from Kerala Agricultural Research Station, Kumarakam. Seedlings were first raised in nursery and 39 days old seedlings were transplanted in to pots.

Treatment structure

T 1 : Soil control

T2 : chemical fertilizers

T2 : Vermicompost

T4 : *Azospirillum* (1%)

T5 : *Azospirillum*(2%)

T6 : *Azospirillum* (3%)

Number of replications : 4

Design : Complete Randomised Design

No. of Pots : 18

Period of study : 2 months

Observations

1 :Plant height
2 :Leaves
3 : Leaf area index

3.13 STATISTICAL ANALYSIS

Observations recorded for all the characters were statistically examined by the procedures suggested by Gomez and Gomez (1984) by the ANOVA table. Wherever the results were found to be significant, critical differences were worked out at 5% level (p=0.05)

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4. RESULTS

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4.1 Isolation and identification of microbes in vermicompost

4.2 Plant growth characters

4.3 Yield Aspects of Brinjal

4. RESULTS

4.1 Isolation and identification of microbes in vermicompost

Table 1 shows the pH of fresh and 3 weeks vermicompost of different treatment. The pH values ranges from 5.8 – 6.5 in fresh cast and 5.3 – 6.1 in 3 weeks vermicompost. pH value of 3 weeks vermicompost comparatively lower than fresh vermicompost.

Table 1. pH of vermicompost

Treatment	pH of fresh vermicompost	pH of vermicompost after 3 weeks
1	6.2	5.8
2	6.5	5.3
3	6.4	5.9
4	6.3	5.7
5	6.4	6.1
6	6.2	6.1
7	5.8	5.8
8	6.4	6.1
9	6.5	5.9

Table 2 shows total aerobic count of different treatments in fresh and 3 weeks old vermicompost. Maximum aerobic count recorded is in T1 and minimum in T4 treatment. Fresh vermicompost shows maximum aerobic count than 3 weeks vermicompost.

Table 2. Total aerobic count vermicompost (cfu/ml)

Treatment (T)	Aerobic count of fresh vermicompost (Mean)	Aerobic count of vermicompost after 3 weeks (Mean)
1	4.5	3.6
2	3.9	3.1
3	2.9	2.5
4	2.6	2.4
5	2.4	1.6
6	2.8	2.4
7	3.1	2.8
8	3.5	3.1
9	3.8	2.9

Table 3 shows total anaerobic count of microorganisms. Maximum anaerobic count recorded is in fresh vermicompost than 3 weeks old vermicompost.

Table 3.Total anaerobic count of vermicompost (cfu/ml)

Treatment (T)	Anaerobic count of fresh vermicompost(Mean)	Anaerobic count of vermicompost after 3 weeks(Mean)
1	1.8	1.5
2	1.6	1.2
3	1.3	1.2
4	1.5	1.1
5	1.8	1.4
6	1.6	1.4
7	1.7	1.1
8	1.2	1.5
9	1.5	1.2

Table 4 shows total fungal count of microorganisms. Almost same fungal count wasobserved in 3 weeks vermicompost and fresh vermicompost.

Table 4 Total fungal count (cfu/ml)

Treatment	Fungi of fresh vermicompost(Mean)	Fungi of vermicompost after 3 weeks(Mean)
1	2.5	2.5
2	2.2	2.3
3	2.3	2.4
4	2.1	2.5
5	1.8	2.1
6	1.9	1.9
7	2.4	2.2
8	1.8	1.9
9	2.5	2.4

Table 5 and 6 shows names of microorganisms isolated from fresh and 3 weeks old vermicompost in different treatments. In all the treatments the highest aerobic count recorded was in treatment 1 and minimum in T4 in fresh vermicompost. In 3 weeks old vermicompost maximum aerobic count recorded was in T1 and minimum in T5. Maximum number of anaerobes recorded was in T1 and T5 in fresh vermicompost and minimum in T8. Maximum no.of anaerobes recorded in 3 weeks vermicompost is T1 and T8 and minimum in T4. Maximum fungal count observed was in T1 and T9 in fresh vermicompost and minimum colony count observed in T5 and T8. Maximum fungal count was observed in 3 weeks old vermicompost in T1 and T4 and minimum in T8 and T6.

Bacterial isolates contains both gram positive and gram negative rods and cocci. A combination of cultural, morphological and biochemical characteristics were used in identifying bacterial isolates as shown in Table 5. Table 6 shows fungal organisms isolated from the vermicompost samples.

Table 5 Distribution of microorganisms in fresh vermicompost

BACTERIA	T1	T2	T3	T4	T5	T6	T7	T8	T9
Staphylococcus Sps.	+	+	+	+	+	+	+	+	+
Bacillus Sps	+	+	-	+	-	+	+	+	+
Pseudomonas Sps	+	+	+	+	-	+	+	+	-
Clostridium Sps	+	+	+	+	+	+	+	+	+
Seretia Sps	-	+	+	+	+	-	+	+	+
Acetobacter Sps	+	+	+	+	+	+	+	+	+
Acinetobacter Sps	+	+	+	+	+	+	+	+	+
FUNGI									
Aspergillus sps	+	+	+	+	+	+	+	+	+
Fusarium sps	-	+	-	-	+	-	-	-	-
Rhizopus sps	-	-	+	-	+	+	-	+	+
Candida sps	+	-	-	+	+	+	+	+	+
Saccharomyces sps	+	-	+	+	-	+	+	+	+
Pichia sps	-	+	+	-	-	-	-	-	-

Table 6 Distribution of microorganisms :3 weeks old vermicompost

BACTERIA	T1	T2	T3	T4	T5	T6	T7	T8	T9
Staphylococcus Sps.	+	+	+	+	+	+	+	+	+
Bacillus Sps	+	+	-	+	-	+	+	+	+
Pseudomonas Sps	+	+	+	+	-	+	+	+	-
Clostridium Sps	+	+	+	+	+	+	+	+	+
Seretia Sps	-	+	+	+	+	-	+	+	+
Acetobacter Sps	+	+	+	+	+	+	+	+	+
Acinetobacter Sps	+	+	+	+	+	+	+	+	+
FUNGI									
Aspergillus sps	+	+	+	+	+	+	+	+	+
Fusarium sps	+	+	+	+	+	+	-	+	-
Rhizopus sps	+	+	+	+	+	+	+	+	+
Candida sps	+	+	+	+	+	+	+	+	+
Saccharomyces sps	+	-	+	+	-	+	+	+	+
Pichia sps	-	+	+	-	+	-	+	+	+

4.2 Plant growth characters

4.2.1. Height of the plant

Effects of treatments on height of the plant at different stages of brinjal growth during 2011 and 2012 are furnished in Table 7.

Significant difference in plant height was observed throughout the plant growing stages with different organic manure application. Plants that recorded in treatment 7 resulted in maximum height at all growth stages. Influence of treatments on the length of the plants, results indicated that vermicompost with microbial inoculation had significant influence on the height of brinjal over other treatments.

4.2.2 No.of leaves

The effect of treatments on number of leaves at different growth stages during the period of study is presented in the Table 8. Vermicompost with microbial fertilizers significantly influenced the number of leaves of plants. At the time of transplantation the no.of leaves in all the treatments were almost same. At the flowering stage of the plants the maximum no.of leaves on treatment 7 showed 17 followed by treatment 8 showed 14. Lowest leaves number showed was in treatment 1 (see control). Between controls significant difference were noted at all stages.

4.2.3 No.of branches

Compared to controls number of branches were higher in treatment 7 followed by treatment 8. No.of branches at the time of harvest were shown in Table 9

4.2.4 Leaf area index

Leaf area index of the plants at the flowering stages were shown in Table 10. Higher leaf axis index were present in treatment 7 followed by treatment 8 compared to other treatments.

4.2.5 Length of the root

Length of the root in each treatment were observed after harvesting the plants. Maximum root length were observed in treatment 7 than treatment 8. Lowest root length were observed in control treatment. (Table 11)

TABLE -7 HEIGHT OF THE PLANT AT FLOWERING STAGE

TREATMENT	REPLICATIONS				
	R1	R2	R3	TOTAL	MEAN
T1	64	59	58	181	60.3
T2	84	84	88	256	85.3
T3	99	110	98	307	102
T4	89	69	76	234	78
T5	99	96	85	280	93.3
T6	94.6	86.8	84.5	265.9	88.6
T7	119	121	118	358	119
T8	102	108	111	321	107
CD					**16.86**

TABLE 8 NUMBER OF LEAVES OF THE PLANT – AT FLOWERING STAGE

TREATMENT	REPLICATION				
	R1	R2	R3	TOTAL	MEAN
T1	8	7	8	23	7.6
T2	11	9	9	29	9.6
T3	10	11	10	31	10.3
T4	12	13	11	36	12
T5	10	12	12	34	11.3
T6	12	10	12	34	11.3
T7	21	17	14	52	17.3
T8	16	14	12	42	14
CD					**2.87**

TABLE 9 NUMBER OF BRANCHES OF THE PLANT AT THE TIME OF HARVEST

TREATMENT	REPLICATIONS				
	R1	R2	R3	TOTAL	MEAN
T1	2	2	2	6	2
T2	4	4	4	12	4
T3	4	3	4	11	3.6
T4	3	4	3	10	3.3
T5	4	3	4	11	3.6
T6	3	4	4	11	3.6
T7	6	5	6	17	5.6
T8	5	4	6	15	5
CD					1.01

TABLE 10 LEAF AREA INDEX

TREATMENT	REPLICATIONS				
	R1	R2	R3	TOTAL	MEAN
T1	0.2845	0.2634	0.2945	0.8424	0.2808
T2	0.3889	0.2635	0.2012	0.8536	0.2845
T3	0.2985	0.2925	0.3215	0.9125	0.3042
T4	0.3215	0.3105	0.3321	0.9641	0.3213
T5	0.3435	0.3012	0.3212	0.9659	0.3219
T6	0.3031	0.3211	0.3121	0.9363	0.3121
T7	0.4607	0.5607	0.4692	1.4906	0.4968
T8	0.4507	0.4202	04012	1.2721	0.4240
CD					**0.46**

TABLE 11 LENGTH OF THE ROOT

TREATMENT	REPLICATIONS				
	R1	R2	R3	TOTAL	MEAN
T1	26	10	24	60	20
T2	37	41	35	113	37.6
T3	49	46	42	137	45.6
T4	48	42	46	136	45.3
T5	44	45	49	138	46
T6	47	47	44	138	46
T7	60	58	59	177	59
T8	52	51	48	151	50.3
CD					**23.59**

4.3 YIELD ASPECTS OF BRINJAL

4.3.1 Total no.of fruits

Total no.of fruits in each treatment was shown in Table 12. Total no.of fruits in each treatment were counted and recorded. Compared to other treatments, treatment 7 showed significantly higher no.of fruits.

4.3.2 Harvest index

Harvest index of the treatments were shown in Table 13. Harvest index was higher in treatment 7 compared to other treatments.

TABLE 12 TOTAL NUMBER OF FRUITS

TREATMENT	REPLICATIONS				
	R1	R2	R3	TOTAL	MEAN
T1	21	22	19	62	20.6
T2	32	31	31	94	31.3
T3	49	38	42	129	43
T4	31	29	26	86	28.6
T5	35	40	39	114	38
T6	36	32	32	100	33.3
T7	44	53	54	151	50.3
T8	46	44	41	131	43.6
CD					**5.7**

TABLE 13 HARVEST INDEX

HARVEST INDEX = TOTAL PLANT BIOMASS X 100
FRUIT BIOMASS

TREATMENT	REPLICATIONS				
	R1	R2	R3	TOTAL	MEAN
T1	1.49	1.42	1.46	4.37	1.45
T2	2.69	2.59	2.89	8.17	2.72
T3	2.613	2.62	2.69	7.92	2.64
T4	3.14	3.21	2.81	9.16	3.05
T5	2.63	2.89	2.91	8.43	2.81
T6	2.56	2.95	2.91	8.42	2.80
T7	3.22	3.52	3.21	9.95	3.31
T8	3.15	3.21	3.11	9.47	3.15
CD					**0.5258**

4.4 QUALITY ASPECTS OF BRINJAL

4.4.1 Nutrient content (Nitrogen, Potassium & Phosphorus)

Nutrient content of brinjal due to the influence of treatments were depicted in tables 14, 15, 16 when compared to other treatments, treatment 7 shows higher total nitrogen value, total phosphorus value & total potassium content.

TABLE – 14 EFFECT OF NUTRIENTS IN THE FRUITS OF BRINJAL- NITROGEN

TREATMENT	REPLICATIONS				
	R1	R2	R3	TOTAL	MEAN
T1	0.95	0.81	0.91	2.67	0.89
T2	1.10	1.12	1.08	3.3	1.1
T3	1.11	1.21	1.02	3.34	1.11
T4	1.12	1.15	1.21	3.48	1.16
T5	1.25	1.09	1.24	3.58	1.19
T6	1.21	1.21	1.18	3.6	1.2
T7	2.59	2.41	2.40	7.4	2.46
T8	1.78	1.95	2.01	5.74	1.91
CD					.073

TABLE 15 EFFECT OF NUTRIENTS IN THE FRUITS OF BRINJAL-POTASSIUM

TREATMENT	%K				
	REPLICATIONS				
	R1	R1	R1	TOTAL	MEAN
T1	2.91	2.91	2.91	8.16	2.72
T2	3.55	3.55	3.55	10.28	3.42
T3	4.01	4.01	4.01	11.8	3.93
T4	3.28	3.28	3.28	10.1	3.36
T5	3.11	3.11	3.11	9.66	3.22
T6	3.25	3.25	3.25	9.59	3.19
T7	4.55	4.55	4.55	13.66	4.55
T8	4.60	4.60	4.60	13.43	4.47
CD					**0.19**

TABLE 16 EFFECT OF NUTRIENTS IN THE FRUITS OF BRINJAL-PHOSPHORUS

TREATMENT	% K				
	REPLICATIONS				
	R1	R2	R3	TOTAL	MEAN
T1	0.38	0.25	0.39	1.02	0.34
T2	0.42	0.41	0.42	1.25	0.416
T3	0.49	0.49	0.52	1.5	0.5
T4	0.48	0.42	0.52	1.42	0.47
T5	0.52	0.56	0.59	1.67	0.55
T6	0.59	0.52	0.57	1.68	0.56
T7	0.65	0.58	0.61	1.84	0.61
T8	0.59	0.58	0.63	1.8	0.6
CD					**0.19**

4.4.2 Total protein content of brinjal

Vermicompost with microbial fertilizers inoculated treatment showed higher total protein value 6.16 mg/l followed as treatment 8 showed 5.9 mg/l. Control treatments received lower proteins content compared to others. Total protein content of brinjal on different treatment were depicted in Table 17.

4.4.3 Total prolin content

A significant increase in prolin content were observed in treatment 8. Changes in prolin content of brinjal on different treatments were shown in Table 18.

4.4.5 Indole Acetic acid mg/l

A significant increase in Indole Acetic acid content were observed in treatment 7 and treatment 8 compared to other treatments. Lowest Indole Acetic Acid value were recorded in control treatment. Indole Acetic Acid content of different treatments were shown in Table 19.

4.4.6 Storage life

It could be observed that the storage life of harvested product was more in the case of fruits from treatments applied with vermicompost mixed with microbial fertilizers.

TABLE 17 PROTEIN CONTENT OF BRINJAL

TREATMENT	REPLICATIONS				
	R1	R2	R3	TOTAL	MEAN
T1	4.24	4.01	4.11	12.36	4.12
T2	6.86	5.92	5.84	18.62	6.25
T3	5.49	5.26	5.21	15.96	5.32
T4	5.69	5.10	5.92	16.71	5.57
T5	5.89	5.75	5.81	17.45	5.81
T6	5.90	5.82	5.85	17.57	5.85
T7	6.18	5.99	6.32	18.49	6.16
T8	5.92	6.10	5.68	17.7	5.9

TABLE 18 ESTIMATION OF PROLIN IN BRINJAL

TREATMENT	REPLICATIONS				
	R1	R2	R3	TOTAL	MEAN
T1	0.76	0.79	0.72	2.27	0.756
T2	1.01	1.21	1.02	3.24	1.08
T3	0.86	0.89	0.85	2.6	0.866
T4	0.95	0.98	0.91	2.84	0.946
T5	1.21	1.25	1.19	3.65	1.216
T6	0.98	0.98	0.92	2.88	0.96
T7	1.51	1.51	1.40	4.42	1.47
T8	1.09	1.15	1.18	3.42	1.14
CD					**0.105**

TABLE 19 INDOLE ACETIC ACID OXIDASE ACTIVITY

TREATMENT	REPLICATIONS				
	R1	R2	R3	TOTAL	MEAN
T1	0.112	0.108	0.114	0.334	0.111
T2	0.357	0.362	0.364	1.083	0.361
T3	0.285	0.292	0.281	0.858	0.286
T4	0.295	0.299	0.301	0.895	0.298
T5	0.301	0.308	0.311	0.92	0.306
T6	0.295	0.281	0.292	0.868	0.289
T7	0.412	0.399	0.415	1.226	0.408
T8	0.341	0.352	0.351	1.044	0.348
CD					**0.107**
CD					**0.467**

Pot culture experiments with *Azospirillum* on growth characteristic of Brinjal

TABLE 20 HEIGHT OF THE PLANT

Period	Treatments					
	T1	T2	T3	T4	T5	T6
At the time of transplantation	11.2	10.4	9.8	12.8	10.6	10.4
15 days	15.7	24.6	15.4	20 .6	22.4	18.4
30 days	23.7	36.2	25.2	30.4	48.9	34.6
45 days	30.1	49.7	36.8	41.1	66.1	51.8
60 days	41.5	68.9	55.8	48.2	86.0	69.8

TABLE 21 NO.OF THE LEAVES OF THE PLANT

Period	Treatments					
	T1	T2	T3	T4	T5	T6
At the time of transplantation	4	4	3	4	3	4
15 days	5	9	6	6	8	7
30 days	10	16	11	14	17	16
45 days	12	18	17	21	34	22
60 days	15	25	24	27	38	29

TABLE 22 LEAF AREA INDEX

T1	T2	T3	T4	T5	T6
.2811	.3984	.3210	.3451	.5216	.3914

Plant height Table 20
In this study maximum plant height were recorded in T5 ie. Azospirillum (2%).and

Minimum plant height were observed in T1(soil Control).

No. of leaves Table 21

Maximum No. of leaves were observed in T5 and minimum No. of leaves inT1

Leaf area index Table 22
Maximum Leaf area index were observed in T5 and T6 and minimum no. of leaves were observed in T1.

5. DISCUSSION

5. DISCUSSION

5.1 EFFECT OF VERMICOMPOST ENRICHED WITH MICROBIAL FERTILIZERS ON THE PRODUCTIVITY OF BRINJAL

The results of total aerobic and anaerobic counts of microflora obtained from earthworm castings (fresh and 3 weeks old) produced by 3 different earthworm species indicated that total number of microorganisms were higher in fresh earthworm casts compared to 3 weeks older casts. Compared to three earthworm species, vermicompost of *Eudrilus eugenia* contains more microbial count than the other two species. More fungal count was observed in 3 weeks old vermicompost compared to fresh vermicompost. Earthworms have been shown to influence greatly the chemical, physical and microbiological properties of substrates they inhabit (Tiwarii 1993). Compared to controls more microbial count was observed in other treatments.

The findings of the present study reinforce the general concept that earthworms use organic matter as a source of nutrition but depend on microorganisms such as bacteria, yeast and fungi for digestion of ingested material as they pass through the worm gut, especially those that the earthworm cannot digest by itself (Wormfacts 2001). Enhanced microbial population and activity in the fresh vermicasts would lead enhanced enzyme activities and nutrient mineralization. But in old vermicasts there was reduced microbial population and activity that may lead reduced enzyme activities and nutrient mineralization. The application of fresh vermicasts and vermicompost to the agriculture field may help to build and sustain more fertility when compared to few days old vermicompost. Fresh vermicompost contains more microbial count, contains more enzymes than the old vermicompost.

Growing population exerted great pressure for increase in the production of food grains. Most of the Indian agriculture land are deprived of some of the essential nutrients for growth and development of crop plants. One of the major essential element for growth of plant is Nitrogen. Nitrogen is provided in the

form of chemical fertilizers like urea, such chemical fertilizers pose health hazard and microbial population problem in soil. In such a situation the biofertilizers like *Azospirillum* play a major role in agriculture.

The nitrogen fixing bacterium, *Azospirillum lipoferum* was first described by Beijerinck in 1925. Later Becking(1963) isolated a strain of *Azospirillum* from African soils resembling Beijernick's *Azospirilla,* which are widely distributed plant growth promoting bacteria, which enhance the development of many important crop and non crop plants.(Dobereiner ,1992).The genus contains many species. Five of them are important. Taxonomists have identified five important species of the genus. The five important species are

1 *Azospirillum lipoferum*
2 *Azospirillum brasiliense*
3 *Azospirillum amazonense*
4 *Azospirillum halopreferance*
5 *Azospirillum irakense*

A.lipoferum and A.brasilience isolated all over the world from soil and the roots of a variety of grasses and cereals. *A.amazonence* was originally isolated from roots of forage grasses and certain palm trees in Brasil, but later found on other parts and other regions. *A.halopraeference* were only been isolated from the root surface of *Leptochola fusca* in the Punjab(Pakistan) *A.irakensis* was only found associated with the roots and the rhizosphere of rice in the region of Iraq.

Azospirilla exhibits diazotrophy under microaerophilic conditions as oxygen and carbon sources are the limiting factors for associative nitrogen fixation (Brock *et al* 1993). In rhizosphere root exudates provide carbon and other factors. Das and Misra reported that malate and succinate were better carbon sources and that glucose and galactose were not metabolized. *Azospirillum* species can utilize nitrogen compounds for growth as long as nitrogen is available in the soil but as the soil nitrogen is depleted the bacteria switch over to diazotrophy (Burris *et al*1991).

Das (1993) reported that *Azospirilla* associate with plant roots by two modes namely the loose and tight binding. Loose binding is by plasmid coded bacterial surface proteins and tight binding is mediated by chromosome coded bacterial surface polysaccharides.

Biosynthesis of growth promoting substances like phytohormones, vitamins antibacterial and antifungal substances by *Azospirillum* is well documented. The most extensively reported growth promoters are indole acetic acid (IAA),

Gibberllines, Vitamines and Siderophores. Pure cultures of *A.brasielence* produced gibberllins and cytokinin like substances and synthesized auxin from tryptophan (Tien *et al*, 1979). Phytohormone biosynthesis by *Azospirillum* influenced the host root proliferation (Prinsen *et al*, 1993) and resulted in increased weight, diameter of stem (Kapulnic *et al* 1982). Legume roots inoculated with *Azospirillum* alone or subjected to combined inoculation with *Azospirillum* and *Rhizobium* had a three and two fold increase in indole acetic acid (IAA) content respectively as compared to the uninoculated roots (Andreeval *et al* 1993).

Plant response to *Azospirillum* inoculation

The major phenomena linked with the plant response are

1 Biological nitrogen fixation
2 Ability to reduce nitrate
3 Hormonal effects
4 Increased mineral nutrition
5 Competitivity

Process of association between *Azospirillum* and the host plant

1. The bacterium chemotactically attracted by the root exudates, both specifically and nonspecifically.
2. It adheres to the root surface. This bind is loose and is mediated by flagella and glycocalyx components. During this step, an agglutination can be induced by plant lectines.
3. There is an exchange of message between plant and bacterium.
4. Cellulose fibrils are produced by *Azospirillum* which anchor the bacterium more tightly to the root surface.
5. A production of plant growth promoting substances by the bacterium and a stimulation of the endogeneous plant hormone production takesplaces.

There are a number of reports of both field and pot experiments performed to investigate the effects of *Azospirillum* inoculation on various members of plants. With *Azospirillum* inoculation the crop plants derive positive benefits in terms of plant biomass and (Okon 1985) grain yield. An extensive colonization by *Azospirilla* to root hair, epidermal cells, cortical intercellular spaces and conducting vessels was observed (Tilak and Subbarao, 1987). Hadas and Okon(1987) studied the effect of *A.brasilience* inoculation on root morphology and respiration in tomato seedlings. Purushothaman (1988) reported that root surface area of rice plants inoculated with *Azospirillum* was significantly greater than in uninoculated plants. Lehri and Mehrotha (1972) reported that yield increases in cabbage and brinjal with *Azospirillum* inoculation. In the present investigation only the morphological characters like height, no. of leaves, and leaf area index of the plant was calculated.

In this study the biofertiliser *Azospirillum* in different concentrations (1%, 2%, 3%), were used. *Azospirillum* inoculated treatments showed significant result compared to other treatments. *Azospirillum* 2% (T5) showed better results compared to others.

Pushpa 1996 found that organically grown tomato plants were taller with more number of branches than inorganically grown ones. The beneficial effect and organic amendments in increasing the growth parameters were reported by Pushpa (1996) in tomato and Anitha (1997) in Chilli. Influence of organic manures and *Azospirillum* on growth, yield and quality of ginger was reported (KAU, 1999). Varma (1995) recorded significantly higher production of new leaves, branches, fruits and dry weight of shoot in bush pepper inoculated with *Azospirillum.* Preliminary data from the studies conducted at Indian cardamom research institute on the use of biofertilizers in cardamom indicate the usefulness of *Azospirillum & Phosphobacteria* for the growth of cardamom (Muthuramalingam *et al*. 2000).

Suresh and Mathur (1989) while studying on crop yield under varied conditions reported that continuous use of inorganic fertilizers alone has detrimental effect on crop production whereas their combination with vermicompost can regulate the nutrient uptake from the soil besides improving the quantity and quality of crop product.

Cornevale (2001) has shown that Vermicompost stimulated mycorrhizal colonision in sorghum root. B.Himeek *et al (*2007) found that inoculation of VAM with vermicompost shared significant improvement in shoot length (52% over control). In the presence of AM, the increase in test area was almost doubled with vermicompost when compared with controls.

Dual inoculation of *Azospirillum and Trichoderma* have some advantages over single or no inoculation. *Azospirillum* could increase mineral nutrition and *Trichoderma* could protect plant roots from soil born pathogens.

Sohawane and Kande (1997) revealed that inoculation of VAM and *Azospirillum or Azotobacter* resulted in higher root colonization and spore count and took less time for bud sprouting in grape wine. They also found that the leaf area was significantly high in co-inoculation with VAM and *Azospirillum or Azotobacter*. Among *Azospirillum and Azotobacter*, *Azospirillum* found superior when used in connection with mixed culture of VAM.

Rao *et al* (1985) reported that dual inoculation with *Glomus s*pecies and *Azospirillum s*ignificantly increased dry matter and grain yield of barley. Dual

inoculation of pearl millet with *Azospirillum brasilence* and VAM together with the basal application of rocky N per ha resulted in highest grown yield of 2.7 ton per ha (Bar and Gautam 1991).

Combined inoculation with *Azospirillum brasilence* and VAM fungi significantly increased growth, plant N, and potassium contents, tuberweight and starch content in sweet potato was reported by Kandswamy *et al* (1988).

Along with increase in productivity, an ecofriendly approach in agricultural practice is becoming increasingly necessary. Excessive use of inorganic fertilizer is unsustainable for any farming practice from economic as well as ecological point of view, this has led to the use of various kinds of biofertilizers eg.*Azospirillum* for fixing nitrogen, solubilising phosphates and decomposing carbon. Nitrogen fixing ability of *Azospirillum* has been reported by many workers. In this study the power of *Azospirillum* in agriculture as a biofertilizer has been emphasized.

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6. SUMMARY & CONCLUSION

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6. SUMMARY & CONCLUSION

The present investigation "Effect of vermicompost enriched with microbial fertilizers on the productivity of Brinjal" was undertaken in the Department of Zoology, Baselius College Kottayam during the period 2010 to 2012. The investigation was aimed at finding the response of vermicompost with microbial fertilizers on productivity of brinjal, investigating the effect of different manures on the quality of product, estimation of the effect of organic manures on the chemical properties of soil. The result obtained and the conclusion drawn as summarized below.

1. The influence of application of vermicompost enriched with microbial fertilizers on the growth components of brinjal like plant height, no.of leaves, leaf area index, root length (after harvesting) and number of branches per plant were significant.
2. Influence of vermicompost with microbial fertilizers on the yield attributes were also significant. Maximum no.of fruits and weight of the fruits were recorded by the treatment(7) using vermicompost with microbial fertilizers as *Azospirillum* and VAM followed by the treatment (8) using chemical fertilizers with microbial agents. Yield per plant as well as yield per plot was maximum for the treatment applied with vermicompost *Azospirillum* and VAM.
3. Maximum Ascorbic Acid content as well as protein were obtained with treatment.
4. Indole acetic acid was also highest recorded in treatment 7 and 8.
5. Influence of organic and inorganic nutrient sources was significant in the shelf life of brinjal fruits. After 5 days and 7 days of storage, maximum percent of unmarketable fruits were observed in the plants received with inorganic fertilizers alone and minimum in plants given with organic manure alone.
6. The lengh of the root system has maximum for treatment using combination of microbial fertilizers with vermicompost.
7. The effect of treatments on the biochemical parameters of test crop were studied. The total protein content of brinjal, total prolin content, Indole acetic acid content were found to be significantly higher in the treatment 7 and then treatment 8. Control treatments recorded lower results.

8. Ascorbic acid content were analysed and found that treatment 7 shows highest compared to other treatments.

From the studies the following conclusion were arrived.

1. For the better production and quality of brinjal, the results significantly showed that treatment using vermicompost enriched with microbial fertilizer as good source of fertilizer compared to controls.
2. Vermicompost with microbial fertilizer significantly influenced the shelf life of brinjal fruits.
3. Generally characters like height of the plant, no.of leaves, branches and leaf area index has significantly increased by the organic fertilizers.
4. In the quantity aspects organic fertilizers using treatment showed significant results compared to other treatments.

7. REFERENCES

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7. REFERENCES

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8 . APPENDIX

RESEARCH PAPERS PUBLISHED ON THE TOPIC

OF

PROJECT WORK

BY

THE PRINCIPAL INVESTIGATOR

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PAGES:81-100

1.Nisha S.Babu and Susan Panicker 2012 Importance of *Azospirillum* species in agriculture. *Baselius Researcher ISSN 0975-8658* VOL 13 No. 1

2. Nisha S.Babu and Susan Panicker 2011 Isolation and identification of Microorganisms from vermicompost produced by different earthworm species *Baselius Researcher ISSN 0975-8658* VOL 12 No. 2

3. Nisha S.Babu and Susan Panicker 2010 The effect of Vermicompost with different microbial fertilizers on the growth and yield of brinjal *Baselius Researcher ISSN 0975-8658* VOL 11 No. 2

THANKYOU

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