NUTRIENT MANAGEMENT IN ORGANIC FARMING OF CUCUMBER (*Cucumis sativus* L.)

By

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(2011-11-135)

THESIS

Submitted in partial fulfilment of the requirement for the degree of

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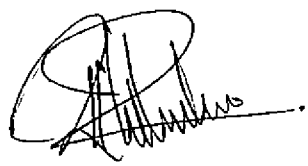
DECLARATION

I, Rasmi Krishnan V. (2011-11-135), hereby declare that the thesis entitled **"Nutrient management in organic farming of cucumber (*Cucumis sativus* L.)** "is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, fellowship or other similar title, of any other University or Society.



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Certified that this thesis entitled **"Nutrient management in organic farming of cucumber (*Cucumis sativus* L.)"** is a record of research work done independently by **Miss. Rasmi Krishnan .V (2011-11-135)** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

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Dedicated to

my loving parents

and

Advisor, Dr. K. E. Usha

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RASMI KRISHNAN V.

CONTENTS

LIST OF TABLES

LIST OF PLATES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

%	-	Percent
@	-	At the rate of
°C	-	Degree selcious
B:C	-	Benefit cost ratio
cm	-	Centi meter
RBD	-	Randomized Block Design
DAS	-	Days after sowing
DMP	-	Drymatter production
dSm^{-1}	-	Deci siemen per meter
EC	-	Electrical conductivity
et al	-	And others
ie	-	That is
K	-	Potassium
kg	-	Kilogram
$kg\ ha^{-1}$	-	Kilogram per hectare
m	-	Metre
LAI	-	Leaf area index

INTRODUCTION

INTRODUCTION

The present day agriculture faces new challenges like decline in productivity, degradation of soil and water resources, diminishing biodiversity and increase in environmental pollution. This has led to think about the alternatives to the chemical agricultural system and organic farming is gaining momentum nowadays. This system integrates the relation between soil, plant, water, soil micro flora and fauna helping in healthy soil, proper energy flow in soil and crop, water environment systems which keeps biological life cycle live and helps in sustaining considerable levels in yield.

The concept of organic farming is gaining popularity among the farmers of our country due to realization of inherent advantages. Organic agriculture has the potential to produce enough food on a global per capita basis to sustain the total human population without increasing the agricultural land base (IFOAM, 2011).

Organic manures play a key role in sustaining crop growth and productivity and the same is mainly applied to soil. Among the organic manures poultry manure, vermicompost, neem cake and groundnut cake are considered to be viable choice in crop production owing to their high nutrient content and other additional benefits. Organic manures, besides being rich source of macro and micro nutrients, act as chelating agents and regulate the plant growth by providing nutrients in the available forms. It also contains large quantities of beneficial microbial population and biologically active metabolites, particularly gibberlins, cytokinins, auxins and group B vitamins.

Among the several methods of eco friendly agriculture, liquid nutrition occupies an important position. Liquid organic manures add much needed organic and mineral matter to the soil and play an important role in soil fertility and

productivity. Commonly used liquid organic manures are *Jeevamrutham, Panchagavya* and fish amino acid.

The demand for high quality and safe food is increasing day by day. Among the food components, vegetables have a vital role in our diet. The unscientific use of chemicals in vegetable cultivation has led to serious health hazards. Use of heavy dose of fertilizers for top dressing also affects the nutrient content and keeping quality of vegetables. As the cultivation of vegetables in homesteads and terrace is gaining popularity, there is a need for an organic phytotonic to substitute fertilizers.

Most of the vegetables contain pesticide residues more than the permissible limits which lead to various kinds of health hazards. In many places trees have stopped bearing fruits because the heavy use of pesticides has killed the pollinators viz. bees and butterflies. Foliar nutrition with organic compounds in vegetables is especially important as they provide quality food, which are very important for providing health security to people. Hence, finding new perspectives for reducing chemical inputs in agriculture and residues in food has become one of the major thrust areas of research.

Organic farming movement in India suffers from lack of adequate institutional and scientific support in areas of research and extension though farmers have come forward with many challenging and inspiring organic nutrient management techniques which they claim to be very competitive. Vegetables like salad cucumber, which is consumed as raw, needs safer approach in cultivation and it is the need of the hour to find out suitable management strategies under organic farming.

Hence, the present study on " Nutrient management in organic farming of cucumber (*Cucumis sativus* L.) " was undertaken with the following objectives:

I) To standardize the nutrient management practices in organic farming of cucumber and

II) To study the effect of different combinations of organic manures and supplements on growth, yield, quality and soil health.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

The review of literature pertaining to the study on "Nutrient management in organic farming of Cucumber (*Cucumis sativus* L.)" is presented in the following sub heads.

2.1 Effect of organic manures on physical, chemical and biological properties of soil

2.2 Effect of organic manures on production of growth promoting hormones

2.3 Effect of organic manures on availability, content and uptake of nutrients in vegetable crops

2.4 Effect of organic manures on incidence of pests and diseases on crops

2.5 Effect of organic manures on growth, yield and quality of vegetables

2.1 EFFECT OF ORGANIC MANURES ON PHYSICAL, CHEMICAL AND BIOLOGICAL PROPERTIES OF SOIL

Organic source of nutrients conserve the soil health by maintaining the equilibrium of organic matter and soil micro flora (Walia and Kler, 2007). Regular additions of organic manure in sufficient quantities help in the maintenance of organic matter content at optimum levels (Thampan, 1993).Organic maures can effectively act as slow release fertilizers and many of the organic amendments bring about pest suppression also (Gaur *et al.*, 1984).

Addition of organic manures like FYM, poultry manure, oil cakes, compost, green manure *etc.* improve the physical, chemical and biological properties of soil and thereby enhance the productivity of soil. Bandyopadhyay (2009) reported an improvement in the physico-chemical properties of soil with the application of vermi compost along with chemical fertilizers in many crops.

Mohan (2008) reported that organic promoters like *panchagavyam* and EM solution could improve the nutrient status of the soil. *Jeevamrutham*, a promising liquid manure, could act as a good soil tonic which enhanced the soil physical, chemical and biological properties (Palekar, 2007).

2.1.1 Effect of organic manures on physical properties of soil

The favourable effect of FYM application on the structural properties of soil was observed by several investigators (Muthuvel *et al.*, 1982). Application of poultry manure decreased bulk density, increased organic matter content, total porosity and water infiltration capacity of soil (Obi and Ebo, 1995). Itnal (1997) noticed that application of maize straw @ 5 t ha^{-1} and cotton residue reduced the bulk density from 1.3 g cm^{-3} (in control) to 1.04 and 1.11g cm^{-3}, respectively. The bulk density was also reduced by combined application of FYM and fertilizers (Mishra and Sharma, 1997). Patil (1998) observed that incorporation of FYM @ 2.5 t ha^{-1} and vermi compost @ 1.0 t ha^{-1} enhanced the soil moisture content compared to fertilizer application in the vertisols of Bijapur.

Sharma *et al.*, (2000) reported a significant reduction in the bulk density which improved the water holding capacity. In vertisols, the bulk density was reduced from 1.32 to 1.28 g cm^{-3} in one season itself and application of composted coir pith and FYM reduced the bulk density appreciably over the control (Patil *et al* ., 2003).

Application of organic amendments viz. saw dust, ground nut shell powder, coir dust and FYM each @ 2.5 and 5 t ha^{-1} improved the soil physical characteristics like infiltration rate, total porosity and hydraulic conductivity of red soil with hard pan. Maximum water holding capacity of soil decreased with application of fly ash while it increased with increasing the level of FYM (Patil *et*

al., 2003). Gill and Prasad (2009) noticed that the bulk density values remained lower (0.12 g /cc) in organic management compared to inorganic and integrated systems during the period of study in Raipur.

The favourable effect of FYM application on the structural properties of the soil was observed by several investigators. According to Chenkai (1993), incorporation of organic residues not only reduced bulk density but also improved soil porosity and nutrient availability. Srikanth *et al.* (2000) found a significant decrease in bulk density (1.27 – 1.18 g cm^{-3}) of soil after harvest of second crop in soil amended with compost compared to the soil applied with fertilizers. Gathala *et al.* (2007) noticed that the application of FYM increased the organic carbon content and lowered the bulk density.

Increase in soil moisture retention due to addition of FYM was observed by Salter and Williams (1963). Organic amendments like vermi compost and vermi wash promote humification, increase microbial activity and enzyme production, which in turn bring about the aggregate stability of soil particles, resulting in better aeration. Bellakki and Badanur (1994) observed a significant decrease in bulk density with the incorporation of sorghum stubbles and subabul loppings @ 5 t ha^{-1} compared to that of fertilizer application. Similar results with the incorporation of FYM and vermi compost as compared to only fertilizer application (Babalad, 1999).

2.1.2 Effect of organic manures on chemical properties of soil

Hapse (1993) reported that the vermi compost application enhanced the organic carbon content of soil as compared to fertilizer alone. In vertisol, application of 5 t each of FYM, sunhemp, subabul and sorghum stubbles for three successive years recorded organic carbon @ 0.68%, 0.61 %, 0.66 % and 0.53 % respectively against the initial level of 0.48% (Badanur *et al.*, 1990). Mastiholi

(1994) reported that organic carbon content of soil after the harvest of rabi sorghum increased due to application of vermi compost.

Mathur (1997) observed that incorporation of 16 t ha^{-1} of FYM accounted for highest increase in organic carbon content of soil. Srikanth *et al.* (2000) noticed an increase in the organic carbon status of soil due to addition of FYM either alone or in combination with fertilizers because of an increase in the addition of root biomass to the soil. Hangarge *et al.*(2004) reported higher organic carbon content, lower pH and EC with the combined application of vermi compost @ 5 t ha^{-1} and cow dung slurry @ 1 L / m^2 and organic booster @ 1 L / m^2. The microbial biomass C and mineralizable N was more with the addition of organic manures. According to Papadopoulos *et al.*, (2006), organically managed soils had higher organic matter content and provided a more stable soil structure than conventionally managed soils.

Shwetha and Babalad (2009) found that the soil organic carbon content and available soil nutrients *viz.* N, P_2O_5, and K_2O were significantly higher with the application of organic manures in combination with fermented organics after harvest of soybean and wheat. The higher organic carbon, available N, P_2O_5 and K_2O values (0.72- 0.74%, 263.40 - 269.60 kg ha^{-1}, 17.50-17.90 kg ha^{-1} and 383-391 kg ha^{1} respectively) were recorded with combined application of organic manures and fermented organic manures.

According to Ravishankar *et al.*, (2008), addition of FYM, vermi compost, neem cake and bio fertilizers significantly contributed to the improvement in soil organic carbon content. Substitution of 50% N as FYM also improved the soil organic carbon. Addition of organic matter have been reported to increase the status of major and micro nutrients along with enhancement of organic carbon and other physical properties of soil (Sur *et al.*, 2010). Jha *et al.*, (2011) reported that under rice – potato – okra system, with different organic and inorganic nutrient

management, the 100% organic nutrient supply system exhibited a pronounced improvement in organic carbon content of soil.

Srivastava (1998) observed that the application of organic manure resulted in increased organic carbon content, total nitrogen and available phosphorus and potassium status of soil. Gupta *et al.*, (1988) noticed significant increase in organic carbon, available nitrogen and available phosphorus content of soil up to 52 days with the application of FYM and thereafter it decreased due to crop uptake.

Yadav and Chhipa (2007) found that the application of FYM up to 20 t ha $^{-1}$ significantly increased the NPK contents of the soil in Jaipur District of Rajasthan. The increase was to the tune of 19.58, 23.30 and 16.49% N, P and K, respectively with the application of FYM up to 30 t ha $^{-1}$ and 25.16 and 19.73 % P and K, respectively with the application of FYM up to 20 t ha $^{-1}$ over control. Bairwa *et al.*, (2009) observed higher amount of available NPK in the experimental plot of okra where FYM, vermi compost and neem cake were applied.

Badanur *et al.*, (1990) reported that available P content of soil was significantly increased with the incorporation of subabul, sunhemp loppings and FYM. They also noticed that the available K was more in FYM treated plots than in fertilizer treated ones. High levels of poultry manure slightly increased the concentrations of leaf Mo and B at the harvest stage of pumpkin. Poultry manure applications had a positive effect on the concentration of Zn and Cu in leaves at both sampling stages (Azeez *et al.*, 2009).

Olsen *et al.*, 1970 observed that addition of manures increases the soil pH. FYM has greater buffering capacity and helps to maintain soil pH. Lal *et al.*,(2000) reported that incorporation of organic wastes like lantana, water hyacinth, subabul leaves, lentil straw, maize stover and rice straw significantly increased the pH of an acid clay loam soil.

2.1.3 Effect of organic manures on biological properties of soil

According to Palekar (2007), the enormous amount of microbes present in *jeevamrutham* enhances microbial activity in soil. Studies conducted by Sreenivasa *et al.*, (2007) also revealed that the beneficial micro organisms in *beejamrutham* enhanced the microbial activity of the soil. Prasanthrajan *et al.,* (2009) observed drastic increase in microbial population and enzyme activity in soils of Coimbatore by the application of poultry manure @ 12 t ha^{-1}.

Delschen (1999) reported that organic farming practices and reduced input strategies could rapidly improve soil microbial characteristics. He also found that fields cultivated organically had higher biological activity than conventionally cultivated fields.

Highest population of bacteria and actinomycetes in the soil was observed in treatments with organic manures + bio inoculants. Rajeshwari (2005) reported significant increase in dehydrogenase activity with the application of FYM. Chandrakala (2008) could notice significantly higher dehydrogenase activity for the treatment with *panchagavyam* in chilli being 27.68 and 22.5 micro grams TPF / gm soil / day on 120 and 160 DAT, respectively.

Shashidhar *et al.*, (2008) found more number of bacterial, fungal and actinomycetes colonies in plots mulched with *Cassia sericea* (32 cfu / g X 10^5 / g), paddy straw (53 cfu / g X 10^4 / g) and sunhemp (53 cfu / g X 10^3 / g) respectively. Different organic manuring treatments gave significantly higher microbial population (fungi, bacteria and actinomycetes) and enzymatic activities in the soil and application of FYM (20 kg / plant) was the best for improving soil quality (Ravishankar *et al.*, 2008). The combined application of fermented organics viz., *Beejamrutham, Jeevamrutham, Panchagavya* along with organic manures such as compost, vermi compost and green leaf manure recorded a higher soil biological activity (Shwetha and Babalad, 2009). The dehydrogenase activity was higher with

combined application of organics and fermented organics than their individual applications and RDF + FYM. The highest dehydrogenase activity of 34.84 g TPF g^{-1} soil day^{-1} was observed with compost + vermi compost + green leaf manure + *Jeevamrutham* + *Beejamruth*am and was on par with the treatment receiving vermi compost + green leaf manure + *Jeevamrutham* + *Beejamruth*am + *Panchagavya*. The lowest dehydrogenase activity of 24.27 g TPF g^{-1} soil day^{-1} was noticed with the application of RDF + FYM on 60 DAS of soybean.

Radhakrishnan (2009) noticed appreciable count of beneficial microorganisms like *Psuedomonas, Azospirillum*, PSB, yeast, moulds and actinomycetes in vermi compost. Prasantharajan *et al.*, (2009) observed maximum microbial population and enzyme activity in soil applied with poultry manure @ 12 t ha^{-1}.The addition of organic manures like FYM, vermi compost and neem cake significantly contributed to the improvement in soil microbial load in maize – rice – green gram cropping system at Tanjavur (Porpavol *et al.*, 2010). Kumar and Singaram (2011) reported increase in dehydrogenase, urease and catalase activity in soil by the application of *panchagavyam* @ 3% as foliar spray.

2.2 EFFECT OF ORGANIC MANURES ON PRODUCTION OF GROWTH PROMOTING HORMONES

Beejamrutham contains several hormones which promote the growth of plants (Palekar, 2007). According to Sreenivasa *et al.*, (2007) the bacterial isolates from *beejamrutham* were capable of producing the growth promoters like IAA and GA. The growth regulators viz. GA and IAA present in *panchagavyam* favour cell elongation and increase physiological activities leading to better yield (Somasundaram *et al.*, 2003).

2.3 EFFECT OF ORGANIC MANURES ON AVAILABILITY AND UPTAKE OF NUTRIENTS

Studies on soil nutrients alone will not give any inference on the influence of various nutrients on plant growth and development. The availability and uptake of nutrients are influenced by several soil and plant factors. Organic manures greatly influence the availability and uptake of major and minor nutrients. Babalad (2005) observed that application of crop residues contributed significantly higher available nitrogen. Mineralization and immobilization of P in soil with the addition of organics have been reported by a number of workers. Channabasavanna and Birdar (2002) opined that the nutrients present in poultry manure is easily available and its direct and residual effect on the crop can be noticed . Patidar and Mali (2002) found that the available N and P in soil increased after harvest of sorghum with FYM @ 10 t ha^{-1}.

According to Pannu *et al.* (2003) all organic materials showed less K fixation. Nalatwadmath *et al.* (2003) recorded a build up of available K only in organic manure treated plots. Hangarge *et al.* (2004) reported that the application of liquid organic slurry @ 2 l m^{-2} along with vermi compost @5t ha^{-1} in chilli resulted in higher available N (353 kg ha^{-1}), P_2O_5 (21 kg ha^{-1}) and K_2O (284 kg ha^{-1}) content in soil than those receiving RDF.

Dademal and Dongala (2004) conducted an experiment to know the effect of application of organic manures and fertilizers on content and uptake of nutrients in okra on lateritic soils of Konkan at College of Agriculture, Dapoli. The results revealed that the application of FYM @ 7.50 t ha^{-1} contributed higher N (2.48 %), P (0.52 %) and K (3.10 %) content in okra. Incorporation of organic residues and FYM enhanced the soil available nutrient status. The highest available N (308 kg ha^{-1}), P (19 kg ha^{-1}) and K (290 kg ha^{-1}) were also recorded with the application of FYM @ 5 t ha^{-1} compared to the organic residue application such as press mud

compost @ 10 t ha $^{-1}$, wheat straw @ 5 t ha $^{-1}$, sugar cane trash @ 5 t ha $^{-1}$ and control under cotton – soybean intercropping in vertisols (Bonde, 2004).

Patil *et al.* (2005) had undertaken studies on the effect of fly ash and FYM on nutrient uptake and yield of onion in Department of Horticulture, MAU, Parbhani during 1999. The results indicated that with increasing levels of FYM (0, 5, 15 and 30 t ha $^{-1}$) there was corresponding increase in uptake of N (ranged from 0.08 to 0.13 g plant $^{-1}$), P (ranged from 0.12 to 0.15 g plant $^{-1}$) and K (ranged from 0.61 to 0.92 g plant^{-1}) by onion besides increasing the yield.

Kondapanaidu *et al.* (2009) reported that combined use of organics (FYM, vermi compost, biofertilizers and *panchagavyam*) resulted in higher uptake of major nutrients in chilli. Chattoo *et al.*, (2010) observed significant influence of organic sources on nutrient uptake and found that application of poultry manure resulted in higher uptake of all major nutrients in onion.

According to Prasanna (1998), the maximum uptake of N was in the treatment receiving the highest level of poultry manure and the value ranged from 33.73 kg ha $^{-1}$ to 37.91 kg ha $^{-1}$. According to Geethakumari *et al.*, (2009), maximum NPK uptake was observed in okra and cowpea when poultry manure, FYM and neem cake were used as sources of nutrients in comparison to others. The application of liquid organics such as cow dung slurry, resulted in higher uptake of N, P and K by tomato plants (1.25 to 1.26 g plant $^{-1}$, 0.07 to 0.08 g plant $^{-1}$ and 0.84 to 0.86 g plant $^{-1}$, respectively) than those which received the RDF (Magray *et al.*, 2011).

Among liquid manures, the combined application of *Beejamrutham* + *Jeevamrutham* + *Panchagavya* and *Panchagavya* alone recorded higher uptake of N, P and K in chilli (Boomiraj, 2005). Palekar (2007) revealed that the availability and uptake of nutrients by crops were increased by the application of *jeevamrutham.*

2.4 EFFECT OF ORGANIC MANURES ON INCIDENCE OF PESTS AND DISEASES ON CROPS

Prasanna (1998) has observed that increasing levels of N in the form of fertilizers increased the vulnerability of brinjal crop to the attack of shoot and fruit borer and epilachna beetle. According to Beaulah (2001), the treatment combination of poultry manure + neem cake + *panchagavyam* was very effective in controlling the fruit fly incidence (26.4 %) when compared to control (38.22 %). Complete suppression of mycelial growth of *Sclerotiana sclerotiorum* in cucumber was possible by the addition of different herbal plant extracts with fresh cow urine and cowdung (Basak *et al.*, 2002). Jayasankar *et al.*, (2002) inferred that 0.9 % of cow's urine as foliar spray by low volume hand sprayer effectively controlled the cercospora leaf spot in field beans.

Solaiappan (2002) reported that the bacteria present in *panchagavyam* acted as a biocontrol agent. Natarajan (2003) reported that 5 % spray of *panchagavyam* could control bacterial blight of paddy crop. Sreenivasa *et al.*, (2007) noticed similar results and reported that the beneficial microorganisms in *beejamrutham* protected the crop from harmful soil borne and seed borne pathogens. Increased productivity and disease resistance in plants was observed by using a modified formulation of *panchagavyam* amended sea weed extract (Sangeetha and Thevanathan, 2010).

An ancient practice of spraying milk on vegetables prevailed to prevent viral diseases. Cow's milk was reported to be an excellent sticker and spreader. As a result, it acts as a good medium for saprophytic bacteria and virus inhibitors (Nene, 1999). Sweet pepper grown under organic culture was reported to have high levels of phenolic compounds and the peroxidase and capsidiol activity had contributed to disease resistance (Francisco *et al.*, 2008).

2.5 EFFECT OF ORGANIC MANURES ON GROWTH, YIELD AND QUALITY OF VEGETABLES

2.5.1 Growth and yield

Lalitha *et al.*, (2000) reported that soil application of organic inputs like vermi compost in combination with vermi wash resulted in better growth of plants by slow release of nutrients. Organic materials such as bio digested slurry, poultry manure, green leaf manure and FYM can substitute inorganic fertilizers to maintain the productivity and environmental quality (Choudhary *et al.*, 2002). It was also observed that soil application of neem cake (0.5 t ha^{-1}) and foliar nutrition with vermi wash (1:1) increased the crop vigour in chilli (George, 2006). Experiments conducted by Abdulla and Sukhraj (2010) revealed that combined application of vermi compost and vermi wash is beneficial in improving the growth and yield of bhindi.

According to Palekar (2007), *beejamruth* is a source of nutrients used for seed or seedling treatment to improve the germination capacity of seed and growth of seedlings. Organic promoters like *panchagavyam* and EM solution enhanced the yield of brinjal (Mohan and Srinivasan, 2008). Combined application of liquid manures like beejamrut, jeevamrut and *panchagavyam* recorded significantly higher growth in chilli (Chandrakala, 2008). Several beneficial bacteria are also present in *beejamruth* and inoculation of these bacterial isolates resulted in improvement in seed germination, seedling length and seedling vigour in soybean (Sreenivasa *et al.*, 2007). The experiment conducted by Gore (2009) revealed that use of a combination of *beejamruth*, jeevamruth and *panchagavyam* on 75 and 160 DAS of tomato increased the enzymatic activities, plant growth, root length and N, P and K content in plants.

Sangeetha and Thevanathan (2010) reported that nodule formation in pulses was the highest in soil amended with low levels of sea weed based *panchagavyam* .

The visual effect of FYM application was that the plants receiving FYM were more vigourous and of a darker colour than the ones which received fertilizers alone.

Omori and Ogura (1972) found that the yield of many vegetable crops increased in direct proportion to the quantity of cattle manure and chicken manure applied to the crops.

Comparison of soil, plant and yield parameters of okra grown under organic and conventional systems showed that plant height, LAI and fruit yield and quality were higher in the organic system compared to the conventional system (Boomiraj and Lourduraj, 2006).

According to Ogunlela *et al.*, (2005), average pod weight and length were increased by cattle manure application in okra. Application of manure @ 6 t ha^{-1} gave the highest pod weight while 12t ha^{-1} produced the highest weight of seeds per pod. Leaf calcium and pod nitrogen were slightly higher for cattle manure when applied earlier @ 12 t ha^{-1} than applied late. The investigation done by Mali *et al.*(2005) in cucumber revealed that the maximum growth, yield, earliness in flowering and harvest with best keeping quality were obtained from combined application of daincha and bulky organic manure as compared to fertilizers. The study conducted during 2005-2006 at IGFRI, Jhansi revealed that all the jaivic and vedic krishi inputs like Amrit pani, *Panchagavya* and Gomuthra improved the crop productivity, soil microbial population and biological activity (Sadanandan and Drand, 2006).

The effect of organic sources of nutrients on growth and yield of tomato on a slightly alkaline soil was studied by Sable *et al.,* (2007). They reported that the organic mode of plant nutrition through various combinations of neem cake and vermi compost was found to be superior to fertilizer alone. A higher number of branches and fruit yield was recorded with the neem cake and 50% N through vermi compost. Facknath and Hurree (2008) reported that the available nitrogen and

potassium were higher in the organic plots. Application of organic manures like FYM and compost and other organic manures like *panchagavyam* significantly increased the plant height, LAI, DMP, number of branches per plant and root nodules per plant over control in all the kharif, rabi and zaid seasons in soybean.

Shekhar and Rajasree (2009) found that the application of FYM @ 20 t ha $^{-1}$ recorded the highest number of fruits per plant (37), fruit weight (38.39g) and yield (42.3 t ha $^{-1}$) in cow pea. Studies done by Pimenlala *et al.* (1984), comparing organic and inorganic grain production system, had also shown that organic farming was more energy efficient. Brinjal was grown organically using pot culture by Patil *et al.* (2009) where the soil was amended organically using oxygenated peptone for soil conditioning. He also reported the improvement in enzyme activity of catalase peroxidase and polyphenol oxidase. Better shelf life, superior taste and better shining of fruits increased its marketability.

Sangeetha and Ganesan (2010) reported the beneficial effects on seed germination and yield in green gram by the application of organic inputs like cowdung, goat manure, poultry manure, leaf compost and FYM. Studies were conducted by Ramassamy (2010) on the comparative effects of vermi compost, FYM, sea weed (*Hypnea muciformis* Lamour) and liquid fertilizers individually and in combination on morphology and yield in okra variety Kumuda 501. The increased LAI and fruit weight were obtained in vermi compost and Vermi compost + liquid fertilizers treatments.

Application of organic inputs like vermi compost in combination with vermi wash resulted in better yield of crops by slow release of nutrients for absorption and supplementation of gibberellins, cytokinins and auxins (Lalitha *et al.*, 2000). The combined use of neem cake (0.5 t ha^{-1} as soil application) and vermi wash (as foliar application) increased the crop vigour and fruit yield of chilli (George, 2006). Chandrakala (2008) found that the combined application of beejamrut, jeevamrut

and *panchagavyam* increased the yield and DMP in chilli. The yield of brinjal could be increased by 33% by the application of organic promoters like *panchagavyam* and EM solution (Mohan and Srinivasan, 2008).

According to Singh (2004), the treatment having FYM with other bulky organic manures gave the highest yield in okra. Taiwo *et al.,* (2003) reported that the application of 5t ha^{-1} of organic based manures led to significant increase in the number of okra pods when compared to fertilizers. Yadav and Chhipa (2007) found that the grain and straw yield of wheat increased significantly with the successive increase in the level of FYM. Application of a combination of *beejamruth*, jeevamruth and *panchagavyam* (1:1:2) on 75 and 160 DAS increased the yield of tomato (Gore, 2009).

2.5.2 Quality of vegetables

Ecofriendly production of vegetables with good quality and nutritive value is gaining importance in recent years. Many developing countries are attempting to mobilize all organic sources of plant nutrients towards crop production (Kumar *et al.*, 1998).

Meirproger *et al.*, (1989) could obtain superior results for organoleptic quality, storage quality, content of vitamin C and sugars when compost was applied to crops like tomato, beet root and cabbage.

Lower levels of nutrients and higher content of vitamin C have been reported in organically grown vegetables and also have anti-carcinogenic impact on human beings. Organic vegetables more readily comply with food requirements of infants and hence recommended for baby foods.

Gennaro and Quaglia (2003) reported higher average Vitamin C content in organic vegetables especially tomato, lettuce, spinach and cabbage. They also reported higher content of phosphorus, magnesium and lower nitrates in organically

grown potatoes, carrot, lettuce, spinach, and cabbage. When an acceptability test was conducted, the panelists preferred organically grown okra soup to the chemically grown variant when they assessed the colour, taste, texture, flavour.

Thybo *et al.* (2006) reported higher dry matter, TSS, citric acid and volatile components in tomato as compared to those obtained from chemical farming. Significant differences were recorded in fruit quality characteristics like colour, brix, pH, acidity, lycopene and phenolic compounds between the organic and inorganically grown tomatoes.

Thimma (2006) conducted an experiment to study the effect of organic manure on growth, yield and quality of chilli under Northern Transition Zone of Karnataka. The quality parameters like oleoresin content increased by 13.89, 6.60, 3.70 and 2.30 % respectively with application of poultry manure @ 7.5 t ha $^{-1}$, vermi compost @ 10 t ha $^{-1}$, FYM (50%) + vermi compost (50%) and FYM (50%) + neem cake (50%) over RDF alone. The extractable colour value also increased from 2.90 to 6.00 % with the application of FYM (50%) + PM (50%) and FYM (50%) + neem cake (50%) over RDF alone. Organic products stand out as having higher levels of secondary plant compounds and vitamin C and have more nutritional value. Organic produce has double the flavonoids, an important antioxidant (Dugan, 2007). The organic tomato fruits contained more dry matter, total and reducing sugars, vitamin C, total flavanoids and beta- carotene, but less lycopene in comparison to conventionally grown tomatoes (Hallmann *et al.*, 2007). The levels of quercetin and kaempferol in organic tomatoes were 79 and 97 % higher than those in conventional tomatoes (Alyson *et al.*, 2007).

Increased water availability caused an accumulation of reducing sugars in potato tubers under organic farming where as such accumulation was not observed under conventional farming (Maggio *et al.*, 2008). As far as quality in terms of dry matter, vitamin C and total carotenoids in lettuce were concerned, maximum dry

matter, vitamin C and total carotenoids were recorded with the sole application of vermi compost @ 6 t ha $^{-1}$ during autumn and spring seasons. Among the integrated treatments of organic and inorganic sources of nutrients, application of 50% RDF + 3 t ha^{-1} vermi compost registered higher values for dry matter, vitamin C and total carotenoids (Mujahid and Gupta, 2010). Modified formulation of *panchagavyam* was found to enhance the biological efficiency of the crop plants and the quality of fruits and vegetables (Natarajan, 2003).

Singh (2004) found that, in okra, the treatment receiving FYM with other bulky organic manures gave the highest yield with good protein content, prolonged shelf life and highest net profit per unit area over other treatments. The treatment having bio-fertilizer with bulky organic manure produced okra fruits with highest vitamin C and lowest nitrate content.

According to Mohan and Srinivasan (2007), foliar application of organic promoters like *panchagavyam* and EM solution increased the quality of fruits in brinjal. Gore (2009) reported that use of beejamrut + jeevamruth + *panchagavyam* at 75 DAS and 160 DAS as foliar spray increased the lycopene content in tomato. In short, organic manures increased quality of fruits and vegetables by reducing the toxicity of poisonous chemicals.The crude fibre content of okra variety Arka Anamika fruits under organic manure treatment was also less when compared to control (Shekhar and Rajashree, 2009).

Linder (1985) found that respiration rate and enzyme activity were lower in organically produced vegetables leading to reduced storage losses. Importance of minerals like boron in keeping quality of fruits and tubers was indicated by Tisdale *et al* (1995) and he found that the application of poultry manure favourably influenced the shelf life of the fruits. The shelf life of snake gourd was also better in treatments receiving poultry manure (Joseph,1998). Extended shelf life in organic

papaya fruits was also reported by Shijini (2010) and it was attributed to higher calcium content in fruits.

2.5.3 Mulching

The beneficial effect of mulching on conservation of soil moisture, lowering of soil temperature and suppression of weed growth were reported by several workers. Use of mulches not only checked the weed growth but also extended the interval of irrigation resulting in saving of water (Shijini, 2010).

Kumar reported that mulched crop of bhindi recorded significantly higher levels of fruit set of 88.1%. The growth characters like plants height, number of leaves, number of fruiting branches, LAI, yield attributes like number of flowers per plant, number of fruits, total fruit weight etc. were higher in mulched situation than in un mulched situation. A field experiment was conducted to elucidate the effect of mulches on yield and quality of winter tomato. Soil organic carbon increased when organic manures were applied compared with the plastic mulches (Tu *et al* ., 2006).

Awodoyin *et al.* (2007) observed that mulching is effective in weed control and conservation of soil moisture and this improvement of crop growing environment resulted in increased growth and fruit yield in tomato. Cover crops and organic mulches have been reported to be beneficial in reducing inputs and increasing soil quality. Baiju *et al.* (2010) reported that a steady and intermediate rate of nutrient release can be assured by the application of green mulch of mixed species which is important for soil fertility management and plant uptake.

Vollmer and Creamer (2010) reported that mulches for no-till organic production gave 50% more yield in onion. Mulching conserve moisture during drought period and completely checks the growth of weeds and reduce the incidence of soil borne diseases in rainy season in trailing tomato. Mehta *et al.*

(2010) suggested that the application of straw mulch also increases the available phosphorus and potassium in soil. Due to mulching with paddy straw higher tuber yield was recorded for potato in the rainfed conditions of Northern Karnataka when limited water was available for cultivation. Paddy straw mulch has shown to reduce soil moisture evaporation losses (Kumar *et al.*, 2010).

2.5.4 Organic sources of nutrients and yield

2.5.4.1. FYM

Sareedha *et al.*, (2007) reported that application of FYM @ 25t ha^{-1} along with foliar spray of vermi wash (1:5 dilution) produced best gherkin fruits with 4.9 cm length, 4.18 cm girth and average yield of 409g per plant. Shekhar and Rajashree (2009) conducted a field experiment to study the influence of different organic manures on growth, yield and quality of okra var. Arka Anamika. The results showed that FYM @ 20 t ha^{-1} recorded the highest yield of 10.39 t ha^{-1} with a B:C ratio of 3.56. Among the organic manures tested, FYM produced maximum fruit yield and biomass. The uptake of N, P, K and micro nutrients in FYM treated plants was significantly superior to conventional farming (Rakshit, 2009).

Sittirungsun *et al.*, (2001) conducted an experiment at Hokkaide in Japan to study the influence of FYM on the yield and quality of Pakchoi (*Brassica chinensis*) and Japanese radish (*Raphanus sativus*) grown without the application of chemicals. They reported that nitrate nitrogen concentration of the vegetable decreased with decrease in nitrogen application, where as the total sugar content increased. Ascorbic acid content was increased with the application of FYM. Among the different treatments consisting of FYM, microbial culture, processed city waste, oil cake pellets and vermi compost the best quality rice with finest cooking and milling quality was obtained from the FYM treated plots. The protein content and total minerals of okra fruit increased with the FYM treatment (Bhadoria *et al* ., 2002).

2.5.4.2 Poultry manure

Srivastava (1998) reported that the production of potato was better when poultry manure was the source of nutrition. He realized 28 kg tubers with poultry manure while only 15 kg tubers was obtained with FYM. In Nigeria, application of 8 t ha^{-1} of poultry manure was found to be optimum as the yield of okra increased by 49% over control (Odeleye *et al.*, 2005). According to Prabhakaran (2008), application of poultry manure increased the yield and fruit size in crops like tomato, papaya, strawberry and potato and a dose of even 40 t ha^{-1} was found to be economical.

Zhou – Dongmei *et al.*, (2005) obtained rapid growth and high Cu and Zn uptake in radish (*Raphanus sativus*) and packchoi (*Brassica chinesis*) due to the application of poultry manure. Improved growth in okra variety Varsha Upahar was noticed by the application of poultry manure in combination with urea than the combination of FYM and vermi compost with urea. The highest mean weight of fruit per plant and quality was obtained with poultry manure (Yadav *et al.*, 2006).

In Namakkal, a field trail was done with different combinations of FYM and poultry manure in cassava, along with inorganics. The study revealed that all the organic manurial treatments resulted in higher uptake of all nutrients, higher tuber yield and higher soil nutrient status (Amanullah *et al.*, 2007).

Poultry manure @ 4 t ha^{-1} recorded significant increase in fruit yield (20.1%) of okra. The leaf nutrient content was also increased with increasing rates of poultry manure (Omotoso and Shittu, 2008). Poultry manure was the most economical in the study on organic nutrient scheduling for okra and cowpea conducted by Geethakumari *et al.*, (2010). In Egypt, higher yield was recorded with poultry manure when compared to plant residues (El-Kader *et al.*, 2010).

2.5.4.3 Vermi compost

Vermi compost is a highly nutritive organic manure and plant growth promoter with high porosity, aeration, drainage and water holding capacity. It contains most of the nutrients in available form and is rich in microbial population and diversity.

Kumaran *et al.*, (1998) observed that the use of organic manures like FYM and vermi compost combined with recommended dose of fertilizers showed better performance in terms of growth and fruit yield of tomato. In an experiment, conducted by Renuka and Ravishankar (2001) in tomato, the application of biogas slurry + FYM and vermi compost alone have recorded maximum fruit size and more number of fruits per plant. It is inferred that tomato crop would respond well to the application of organic manures either in combination with FYM or alone. Further, organic manure application helped to maintain the soil health.

Tomar *et al.*, (1998) found that brinjal and carrot plants recorded maximum yield with FYM and vermi compost compared to unamended soil. Reddy and Reddy (2005) reported that the yield of onion increased significantly with increasing level of vermi compost (from 10 to 30 t ha^{-1}) and nitrogen fertilizer from 50 to 200 kg ha^{-1}. Yadav and Vijayakumari (2006) conducted an experiment to evaluate the effect of vermi compost and fertilizers on the yield parameters of chilli and found that higher number of fruits per plant, fruit weight, fruit length and fruit diameter were obtained by applying vermi compost alone. Vermi compost works as a soil conditioner and its continued application leads to total improvement in soil quality (Sinha *et al.*, 2009). The fruit length, fruit thickness, fruit number, fruit weight and fruit yield could be increased in okra by the application of vermi compost (Bairwa *et al.*, 2009).

Sutaria *et al.*, (2010) reported that organic farming could be adopted by applying enriched compost @ 6 t ha^{-1} or vermi compost @ 2 t ha^{-1} alone prepared

from the farm residue for maintaining soil fertility and obtaining good quality products.

2.5.4.4 *Panchagavya*

In addition to nutrients, *panchagavyam* contains numerous beneficial microorganisms like lactic acid bacteria, nitrogen fixing bacteria, phosphate solubilizing bacteria, fungi and also some plant growth promoting substances like indole acetic acid, proteins, carbohydrates, fats, amino acids, vitamins, enzymes which help in improving soil fertility, plant growth, metabolic activity and resistance to pests and diseases (Ruvusaheb, 2008 and Natarajan, 2003).

2.5.4.4.1 Nutrient content in *panchagavyam*

The major ingredients of *panchagavyam* are cowdung, urine, milk, curd and ghee. The cow dung contains 82 % water and 18 % solid matter which constitutes 0.1 % minerals, 2.4 % ash ,14.6 % organic carbon , 0.4 % Ca and Mg , 0.05 % SO_3 ,1.5 % Silica ,0.5 % N ,0.2 % P and 0.5 % K (Singh, 1996). According to Patnaik (1997), the N, P and K content of cow dung is 0.3-0.45%, 0.1-0.2 % and 0.1-0.3 %, respectively and that of cow's urine is 0.9-1.2 %, trace and 0.5-1.0 %, respectively. Reddy (1998) revealed that cow's urine is a rich source of urea and act as a nutrient as well as a hormone. It contains 91% water and 9% solid matter which includes 1.4% minerals, 2.0% ash, 6% organic carbon, 0.15% each of Ca and Mg, 0.15% SO_3 , 0.01% silica, 1.0% N, traces of P and 1.35 % K. Linda Mc Graw (1999) stated that the nutrients in milk are protein, fat, carbohydrates, amino acids, calcium, hydrogen, lactic acid and *Lactobacillus bacterium.*

2.5.4.4.2 *Panchagavya* as plant growth promoter

Panchagavya is the fermented organic manure with high microbial load which include Effective Microorganisms (EM) and Methylotrophs Profile Bacteria (MPB). Apart from this, MPB are known to produce cytokinins and auxins

(Iyanova *et al.,* 2001), which was found to be a part in *panchagavyam* and play a major role in increasing the plant height as a growth promoter. The *panchagavyam* treated plants were found to have the highest plant height and a manifold increase in plant height was noticed with increase in *panchagavyam* concentration.

Panchagavya, when sprayed on foliage facilitates instant uptake of nutrients (Sharma,1970) which leads to the effective conversion of vegetative phase to flowering phase. Further, the enhanced vegetative growth coupled with adequate reserved food materials promotes easy differentiation of vegetative buds into flower buds leading to earliness in flowering and increase in the number of flowering shoots.

The enhancing effect of *panchagavyam* in vegetative phase accompanied with highest number of flowers in reproductive phase positively contributed to the highest number of fruits per plant.

Similarly, the reproductive growth was also positively affected by *panchagavyam* , resulting in earliness of a crop due to the cell differentiation and flower bud formation activity of the cytokinin present in *panchagavyam* . In rose cultivars viz. Edouard (*Rosa bourboniana* Desp) and Red rose (*Ropsa centifolia* L), a treatment of calcium acetate 0.5% + *Panchagavya* 5% proved to be effective in improving the height of the bush in both the cultivars on 30^{th} and 60^{th} DAP (Thamaraiselvi, 2001).

The number of flowering panicles per tree and number of flowers per panicle were increased by the application of a combination of organic manures like poultry manure (500gm), neem cake (250gm) and *panchagavyam* 2% (Beaulah, 2001). A foliar spray of 3 % *panchagavyam* on field bean increased the flowering and fruiting substantially after a week period (Jayasankar *et al.*, 2002).

Reddy (1998) reported that application of modified form of *panchagavyam* 3 % along with neem cake 250 g / m^2 in tomato recorded maximum shoot and root length and DMP along with high fruit yield of 16.7 t ha^{-1} over control (14.1 t ha^{-1}). Vivekanandan (1999) observed enhanced growth and yield of rice with a spray of 3% *panchagavyam* on 25 DAS and 40 DAS and this helped to advance the paddy harvest by 10 days.

Gomathinayagam (2001) carried out an experiment by irrigating the kitchili samba, an indigenous rice variety with cowdung solution on 25 DAP and spraying 1% cows urine solution and 3% *panchagavyam* on 30 DAP and 40 DAP respectively. He could get 1400 kg ha^{-1} grain and the crop was ready for harvest by 130 DAP.

Beaulah (2001) reported that in moringa, a treatment combination of *panchagavyam* 2 % + poultry manure 500 g + neem cake 250 g + 150:150:75 g of NPK per pit recorded the highest yield of 23.08 and 37.95 kg per tree in main and ratoon crops. Natarajan (2003) implied that a 3% spray of *panchagavyam* on Yazhpanam moringa before the end of flowering stage produced 1000 fruits per harvest. An increased yield was obtained in lemon when *panchagavyam* 3% was sprayed during the vegetative and flowering stages.

Somasundaram *et al.*, (2003) reported that 3% *panchagavyam* was the ideal concentration for foliar spray on green gram variety CO - 4. He also predicted that foliar application of *panchagavyam* @ 3% on 15, 25, 40 and 50 DAS with no inorganics was the effective low cost technology for green gram production. A treatment combination of *panchagavyam* + vermi compost on French bean gave 36% higher pod yield than conventional methods. It has also been reported that application of FYM @ 25 t , biodynamic compost@ 5t, neem cake @ 5 t, *Azospirillum* and *Phosphobacteria* @ 2kg/ha and foliar spraying of *panchagavyam* @ 3% at monthly intervals recorded the increased plant height, number of branches,

number of leaves, leaf length and width in the case of thyme and rosemary. The yield, oil content and benefit: cost ratio were high for the same treatment in both the crops.

2.5.4.4.3 Effect of *panchagavyam* on microbiological consortia of soil

Effective micro organisms (EM) are the mixed culture of naturally occurring beneficial microbes [predominantly lactic acid bacteria (*Lactobacillus*), yeast (*Saccharomyces*), actinomycetes (*streptomyces*), photosynthetic bacteria (*Rhodopsuedomonas*)] which are also found to be present in *panchagavyam* . Certain fungi (*Aspergillus*) improved the soil quality and growth and yield of sweet corn (Xu and Xu, 2000).

In *panchagavyam* , proven biofertilizers such as *Azospirillum*, *Azotobacter*, Phosphobacteria and *Psuedomonas* were found besides *Lactobacillus*, as reported by Solaiappan (2002). Malathy (2003) observed that tomato showed greater response for the application of *panchagavyam* . It was found that the treatment receiving *panchagavyam* @5% at nursery stage and 40 DAP along with coconut milk spraying (@10 % once in a week for 3 times) recorded the highest number of fruits per plant of 71.40, followed by 71.0 in the treatment receiving *panchagavyam* @5 % spray at nursery stage alone. Similarly, the fruit quality parameters viz. TSS, total acidity and ascorbic acid content were also the highest in the same treatment (7.5^0 Brix, 0.73% and 16.8 mg/ 100g, respectively).

In a study conducted with *Coleus forskohlii* application of *panchagavyam* @ 4% spray was found to be superior with respect to root yield (12.40 kg/plot) as compared to control (5.23 kg/plot). Similarly, number of roots (14.99), root length (13.73), root diameter (2.49) and root weight (459.35 g/plant) were the highest in the above treatment (Kanimozhi, 2003).

An experiment was conducted to study the effect of *Panchagavya* and moringa leaf extract on growth and yield of bhendi "Varsha Upahar" at Coimbatore. Four sprays of *panchagavyam* @ 3 % and moringa leaf extract (25 ml/plant) were given starting from 2 weeks after sowing and subsequently at 15 days interval were given. Both *panchagavyam* and moringa leaf extract registered higher plant height and number of branches while the number of fruits and fruit yield were the highest in *panchagavyam* treated plants (Muthuvel, 2002).

Thamaraiselvi (2001) conducted an experiment on the physiology of petal shedding in Edward rose and red rose. It was found that the treatment with calcium acetate 0.5 % + *panchagavyam* 5% significantly influenced the morphological characters such as the flower diameter, pedicel length, receptacle diameter, number of petals and petal : receptacle ratio. The foliar spray of *panchagavyam* (5%) also resulted in earlier flowering (45.6 days and 53.31 days in Edward rose and Red rose, respectively).

2.5.4.5 Fish amino acid

Abhilash (2011) reported 20% more yield in red amaranthus and confirmed boost in growth and colour when fish amino acid was given as foliar spray.

2.5.4.6 *Beejamrutham*

Sreenivasa *et al.*, (2007) reported that the nitrogen fixation and P solubilization capacity of the soil could be increased by the inoculation of bacterial isolates from *beejamrutham.*

2.5.4.7 *Jeevamrutham*

In addition to nutrients, *Jeevamrutham* contains numerous beneficial microorganisms like lactic acid bacteria, nitrogen fixing bacteria, and phosphate solubilizing bacteria and also some plant growth promoting substances like indole

acetic acid which help in improving soil fertility, plant growth, metabolic activity and resistance to pests and diseases. Keeping *Jeevamrutham* for different incubation periods revealed that the nutrient status of *Jeevamrutham* decreases through volatilization and leaching as days of incubation increases. Hence, *Jeevamrutham* should be used within 5 days after 48 hours of incubation.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The present investigation on "Nutrient management in organic farming of cucumber (*Cucumis sativus* L.)" was carried out in College of Horticulture, Kerala Agricultural University, Vellanikkara, Thrissur during 2012-2013.

3.1 General details

3.1.1 Experimental site

The experiment was conducted in the Agronomy Research Farm of College of Horticulture,Vellanikkara. Geographically, the area is situated at 10^0 31' N latitude and 76^0 13' E longitude and at an altitude of 40.3 m above MSL.

3.1.2 Soil

The soil of the experimental site is sandy clay loam in texture (order: ultisol). Physico-chemical properties of the soil are given in the Appendix I.

3.1.3 Climate

The meteorological data during the period of study is presented in Appendix II.

Plate1. Overall view of the experimental field

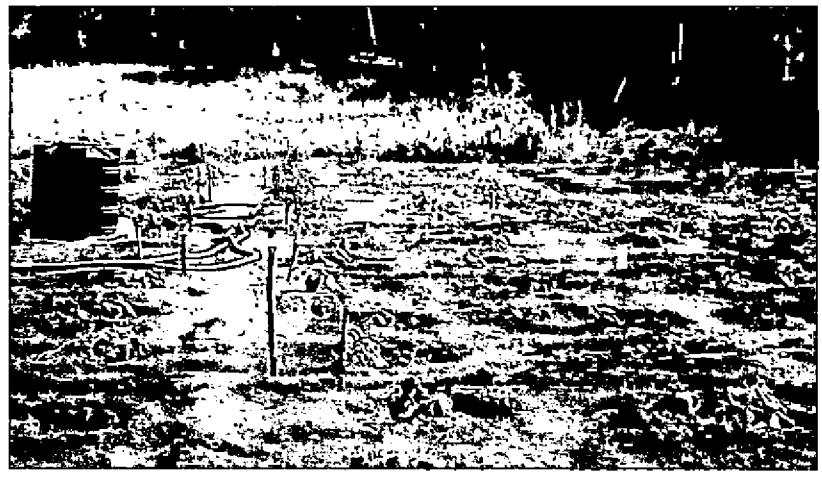


Plate1. Overall view of the experimental field

Fig.1. Weather data during the crop period (26-11-2012 to 31-03-2013)

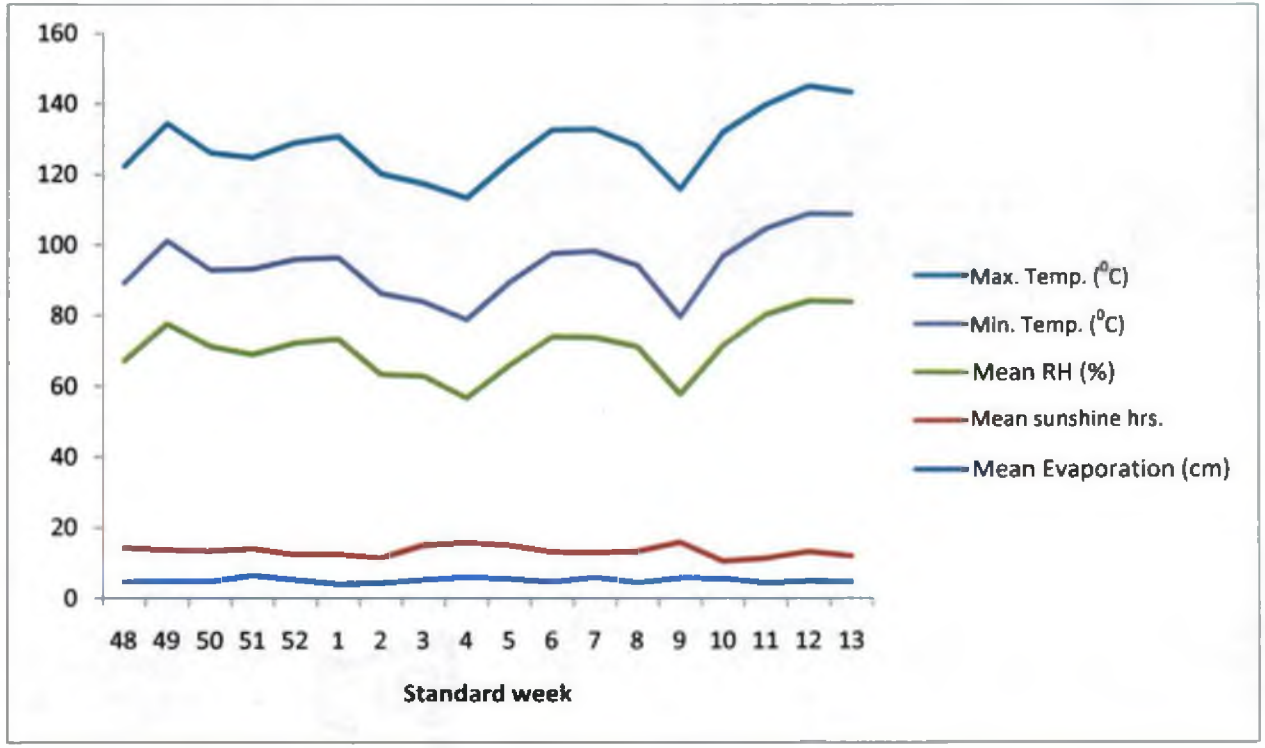
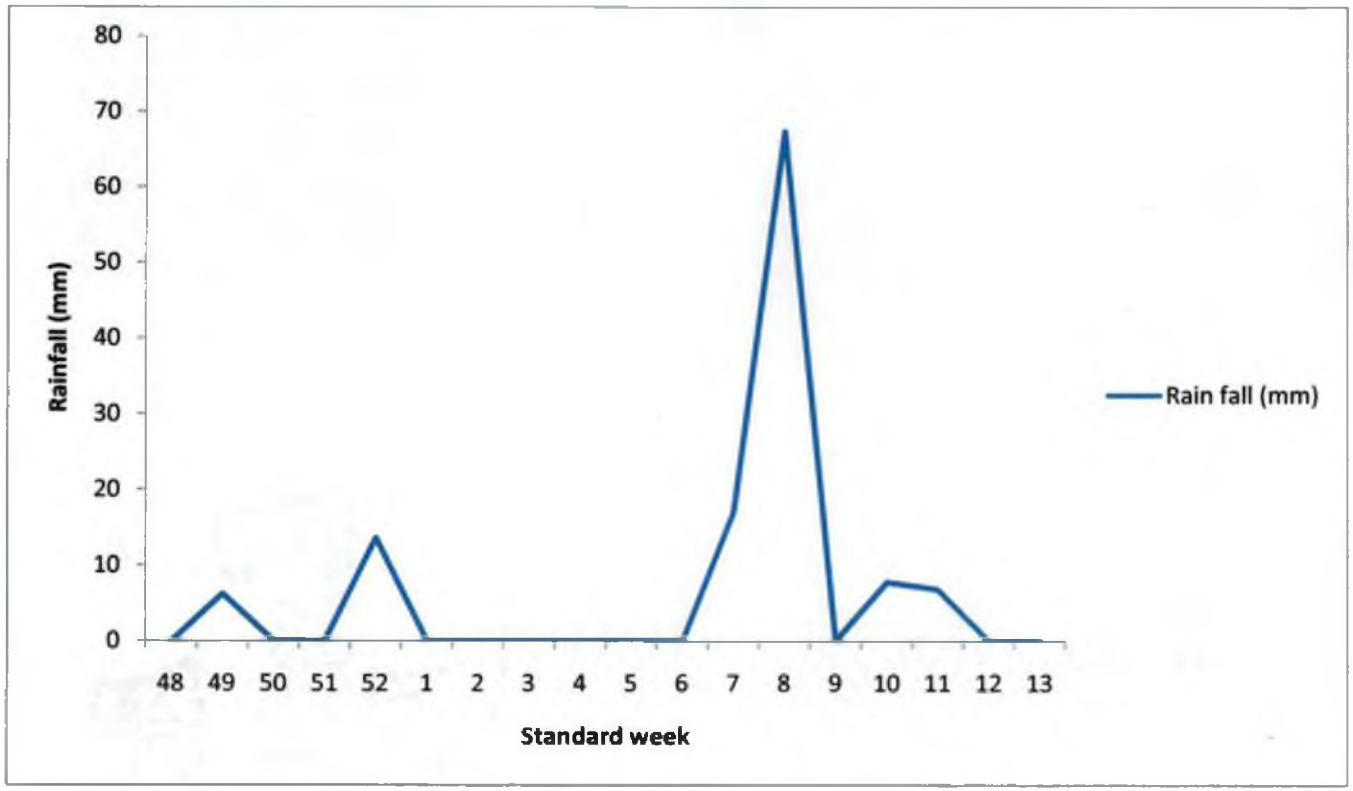


Fig.2. Rainfall data at Vellanikkara during the crop period (26-11-2012 to 31-03-2013)



3.1.4 Season of experiment

The experiment was conducted during November, 2012 - February, 2013.

3.2 METHODS

3.2.1 Crop variety

The salad cucumber variety, AAUC-2, recommended for cultivation by Kerala Agricultural University, was used for the study.

3.2.2 Technical programme

Design - RBD

Replications - 3

Spacing - 2.0 m X 1.5 m

Plot size - 8 m X 6 m

Treatments - 13

3.2.3 Treatments

T_1 – FYM 20 t/ha + N P K 70:25:25 kg/ha (Package of practices recommendations by KAU)

T_2 – FYM 20 t/ha

T_3 - NPK (70:25:25 kg/ha)

T_4 - Poultry manure equivalent to N in FYM 20 t/ha

T_5 - Poultry manure equivalent to N in FYM 20 t/ha + NPK

T_6 –FYM 12t/ha + Vermi compost (4 t/ha-1/2 at vining and 1/2 at flowering stage) + fresh cow dung slurry @ one kg/l of water per pit at fortnightly

interval starting from flowering (Adhoc recommendation by KAU)

T_7 - Poultry manure equivalent to N in FYM 10 t/ha and neem cake equivalent to N in 10 t/ha (3 splits-poultry manure as basal and neem cake as 2 top dressings)

T_8 - Seed soaking in *Beejamrutham* +soil drenching with *Jeevamrutham* (15 DAS, 30 DAS, 45 DAS) 1L per pit + mulching

T_9 - Poultry manure equivalent to N in FYM 20t/ha + seed soaking in *Beejamrutham* + soil drenching with *Jeevamrutham* (15 DAS, 30 DAS, 45 DAS) 1L per pit + mulching

T_{10} - Poultry manure equivalent to N in FYM 20 t/ha + seed soaking in *Beejamrutham* + foliar spraying of *Jeevamrutham* (15 DAS, 30 DAS, 45 DAS)

T_{11} - Poultry manure equivalent to N in FYM 20 t/ha +foliar spraying of *Panchagavyam* (15 DAS, 30 DAS, 45 DAS)

T_{12} - Poultry manure equivalent to N in 20FYM 20 t/ha + foliar spraying of fish amino acid (15 DAS, 30 DAS, 45 DAS)

T_{13} - Absolute control

Seeds in treatments 2, 4, 6, 7, 11, 12 were treated with bio fertilizers (*Azospirillum* and phosphate solubilising bacteria) and *Pseudomonas* before sowing.

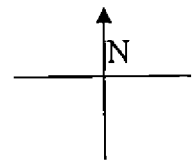


Fig.3. Layout plan of the experimental field

	T_{13}	T_{11}	T_1	T_2	T_8	T_{12}	R_1
T_9	T_{10}	T_7	T_4	T_5	T_6	T_3	
T_2	T_5	T_6	T_3	T_{11}	T_{13}		R_2
T_7	T_1	T_4	T_{12}	T_{10}	T_8	T_9	
T_{11}	T_4	T_8	T_6	T_9	T_{12}		R_3
T_1	T_7	T_3	T_5	T_2	T_{13}	T_{10}	

T_1 - POP
T_2 - FYM alone
T_3 - N P K alone
T_4 - PM
T_5 - PM + N P K
T_6 - Adhoc POP
T_7 - PM + NC
T_8 - Beejamrutham+ Jeevamrutham + Mulching
T_9 - T8 + PM
T_{10} - PM + Beejamrutham + Jeevamrutham+ Without mulching
T_{11} - PM + Panchagavya
T_{12} - PM + Fish amino acid
T_{13} - Control

Methods of preparation of *beejamrutham*, *Jeevamrutham*, *Panchagavya* and Fish amino acid are as follows.

Beejamrutham

50g of slaked lime and 500g undisturbed soilwere added to 25 L of cow dung slurry. Cow urine (5L) was also added to it and mixed thoroughly. Seeds were soaked in that for 2 hours and used for sowing.

Jeevamrutham

10kg cow dung, 10L cow urine, 2kg green gram (germinated), 500g undisturbed soil and 2L coconut water were added to 2L water and mixed well. Stirring was done twice a day in clock wise direction and was applied on 7^{th} day.

Panchagavya

7kg Cow dung and 1kg ghee were mixed in a clean container thoroughly both in morning and evening hours and kept aside for 3 days. After 3 days, 10L cow urine and 10L water were added. The mixture was kept for 15 days with regular mixing both in morning and evening hours. After 15 days, 3L cow milk, 2L curd, 3L tender coconut water, 3kg jaggery and 12 numbers of well ripened poovan banana were also added and mixed well. *Panchagavya* was sprayed on 22^{nd} day at a concentration of 3%. Physico-chemical and microbial properties of *panchagavyam* is presented in Appendix III (Vadivel., 2007)

Fish amino acid

5kg fish and 5 kg jaggery were mixed properly and kept it an air tight container for 21 days with out any disturbance. 10 ml of fish amino acid was diluted with 1L of water and sprayed.

3.2.4 Cultural operations

The experimental area was ploughed, levelled and pits were taken (60 cm diameter and 30 cm depth) at a spacing of 2 m X 1.5 m. Seeds were sown at recommended spacing. Gap filling and thinning were done to secure a uniform stand of the crop (3 plants / pit). Weeding was done as and when required. Nutrients were given as per the schedule mentioned in the treatments.

3.2.5 Observations

Nine plants per replication were selected from each treatment for taking observations. The following parameters were recorded and the average was worked out for further analysis.

3.2.5.1 Soil characteristics

Soil samples were collected separately from each experimental plot in the beginning and at the end of the experiment. The soil samples were air dried and analyzed for physical and chemical characteristics.

3.2.5.2 Microbial population in soil

The microbial count of the soil samples were enumerated before the experiment, 15 DAS and 30 DAS .The method used for the enumeration was serial dilution and plate count technique as described by Agarwal and Hasija (1986).Ten grams of soil was added to 90 ml sterile water and agitated for 20 minutes. One ml of the solution was transferred to a test tube containing 9 ml sterile water to get 10^{-2} dilution and similarly 10^{-3}, 10^{-4}, 10^{-5} and 10^{-6} dilutions were also prepared.

Enumeration of total microbial count was carried out by using different suitable media as detailed in Appendix IV. Suitable media (15-20 ml) was poured on the corresponding medium. Plates were incubated at $28+2^{0}$C. Observations were taken as and when the colonies appeared (For bacteria-2-3 days, fungi - 5-7 days and actinomycetes-3-14 days).

3.2.5.3 Growth characters

3.2.5.3.1 Germination percentage

The number of days taken for germination was noted and the percentage of germination was recorded on 4 DAS and 7 DAS.

3.2.5.3.2 Length of vines

The length of vines (cm) was taken from the base to tip at 15 days intervals (15 DAS, 30 DAS and 45 DAS).

3.2.5.3.3 Number of leaves

The number of leaves was counted at 15 days interval (15 DAS, 30 DAS and 45 DAS).

3.2.5.3.4 Number of branches

The number of branches was counted at 15 days interval.

3.2.5.3.5 Dry Matter Production

The whole plant with leaves, stem and roots were oven dried at 50+5^{0}C to constant weight. The final dry weight was worked out and expressed as total DMP (g plant^{-1}).

3.2.5.4 Physiological characters

3.2.5.4.1 Chlorophyll content

Total chlorophyll content in the leaves was estimated on 15, 30 and 45 DAS. The first fully opened leaf from the top, selected as index leaf, was removed from the plant for chemical analysis. 0.2 g of finely cut sample was taken in a beaker and 10 ml of DMSO (Dimethyl sulphoxide) solution was added. This was kept in a dark place overnight and the next day, made up to 25 ml in a volumetric flask after filtering. The chlorophyll content was read at two wavelengths *viz.* 663 and 645 nm. Using equations given below, chlorophyll a,

chlorophyll b and total chlorophyll were estimated. Chlorophyll content of index leaf was estimated colorimetrically using Spectrophotometer (Yoshida *et al.*,1972).

$$\text{Chlorophyll a (mg/g)} = 12.7 \times \text{OD at 663 nm} - 2.69 \times \text{OD at 645 nm} \times \frac{V}{100 \times W}$$

$$\text{Chlorophyll b (mg/g)} = 2.9 \times \text{OD at 645 nm} - 4.63 \times \text{OD at 663 nm} \times \frac{V}{100 \times W}$$

$$\text{Total Chlorophyll (mg/g)} = 8.02 \times \text{OD at 663} + 20.2 \times \text{OD at 645} \times \frac{V}{100 \times W}$$

3.2.5.4.2 Leaf Area Index (LAI)

Leaf area was measured using Leaf Area Meter and the LAI was worked out using the formula suggested by Watson (1962) at 15 days intervals.

$$\text{LAI} = \frac{\text{Leaf Area}}{\text{Land Area}}$$

3.2.5.5 Yield and yield attributes

3.2.5.5.1 Days to first flower opening

The number of days was counted from the date of sowing to the opening of the first female flower and recorded.

3.2.5.5.2 Number of fruits per plant

The total number of fruits produced per plant at the time of each harvest was recorded and the average was worked out.

3.2.5.5.3 Average fruit weight

Nine fruits per replication were selected from each treatment and the average weight (g) was worked out.

3.2.5.5.4 Fruit length

Nine fruits per replication were selected from each treatment and the average length (cm) was recorded.

3.2.5.5.5 Yield

Fruits were harvested separately from each plot periodically, weighed and the total yield (t ha^{-1}) was worked out.

3.2.5.5.6 Days to first harvest

The number of days from sowing to the date of first harvest of the fruits was noted.

3.2.5.5.7 Number of harvest

The total number of harvests was recorded.

3.2.5.5.8 Crop duration

The number of days from sowing to the date of final harvest of fruits was recorded.

3.2.5.5.9 Flesh thickness (cm)

Thickness of flesh in fruits (cm) were measured and recorded.

3.2.5.5.10 Number of seeds per fruit

The number of seeds in fruits of 5^{th} harvest was counted and recorded.

3.2.5.5.11 Uptake of N, P and K

Three plant samples were collected from each treatment. The fruit, leaf, shoot and root samples were dried in a hot air oven at 50^0C. Drying was continued till the samples attained constant weight. The per cent content of each nutrient was multiplied with the dry weight of root, stem, leaf and fruit separately for NPK and the total uptake was calculated in kg ha^{-1}. Major nutrient content (N, P, K) was estimated as per the procedure given in Appendix V.

3.2.5.6 Quality attributes

3.2.5.6.1 Organoleptic evaluation

A selected panel of judges tasted the harvested fresh fruits for organoleptic evaluation using the score cards. Score card including the quality attributes like odour, colour, texture, taste, after taste and overall acceptability was prepared for the organoleptic evaluation of cucumber. Each of the above mentioned qualities were assessed by a 9 point hedonic scale. Overall acceptability was calculated separately using the average of above mentioned quality attributes. The score card used for the evaluation of cucumber is given in Appendix VI.

3.2.5.6.2 Shelf life

Five fruits from each treatment were harvested and kept in open condition. Observations were taken up to the day on which the fruits started expressing the sign of shrivelling and loss in physical appearance.

3.2.5.7 Incidence of pests and diseases

The incidence of pest and diseases were observed and recorded.

3.2.5.8 B : C Ratio

Benefit : Cost ratio was worked out as per the formula given below.

$$\text{BCR} = \frac{\text{Gross return}}{\text{Cost of cultivation}}$$

3.2.5.9 Statistical analysis

Data pertaining to different characters were tabulated and subjected to statistical analysis using the M STAT-C package (Federe,1955). The score of organoleptic evaluation were analyzed by Kendall's test.

Plate 2. Field operations

Ploughing

Manuring

Sowing

Preparation of Panchagavyam

Panchagavyam

Mulching

RESULTS

4. RESULTS

The results pertaining to the study on " Nutrient management in organic farming of cucumber (*Cucumis sativus* L.) " are furnished below.

4.1 SOIL ANALYSIS

4.1.1 pH

The pH of the soil after the experiment is furnished in Table 1. The initial pH of the soil was 4.51. The treatment receiving Poultry manure + jeevamrutham + beejamrutham + mulching recorded the highest pH (5.62) after the experiment, which was followed by T_{12}.

4.1.2 EC

The EC of the soil after the experiment furnished in Table 1 revealed that the different treatments had no significant influence on soil EC. There was no change in the value of EC (0.011 dSm^{-1}) except in T_4, T_5, T_6.

4.1.3 Organic carbon content

The initial organic carbon of soil of experimental area was 1.20% (Table 2). After the experiment, the treatment receiving FYM and vermi compost (T_6) recorded the highest organic carbon content of 1.44 % and was on par with T_8. The lowest value (1.20%) was recorded in control plots.

4.1.4 Available Nitrogen

The available nitrogen content of soil after harvest is furnished in Table 2. The highest content of available nitrogen was recorded in T_6 (Adhoc POP) with a value of 534 kg ha^{-1} which was significantly superior to other treatments. The lowest content was recorded by T_{13} (488.57 kg ha^{-1}).

4.1.5 Available Phosphorus

The data given in Table 2 clearly showed the significant influence of treatments on available phosphorus content in soil after the experiment. T_6 (Adhoc POP) recorded the maximum P content (31.37 kg ha^{-1}), followed by T_5 (30.77 kg ha^{-1}) while the lowest content was registered by T_{13} (24.19kg ha^{-1}).

4.1.6 Available Potassium

The treatments significantly influenced the available potassium content of soil after harvest (Table 2). The highest value (314.95 kg ha^{-1}) was recorded in T_6 (Adhoc POP) which was on par with T_5. The lowest content was recorded by T_{13} (240.70 kg ha^{-1}).

4.2 MICROBIAL POPULATION IN SOIL

The data on microbial population in soil is furnished in Table 3. It shows that there was significant difference in the microbial count among the treatments at all the stages of growth.

The initial population of fungi, bacteria and actynomycetes were 33 cfu g^1, 29 cfu g^{-1} and 61cfu g^{-1} , respectively. T_9 (PM + Beejamrutham + Jeevamrutham + Mulching) recorded maximum fungal population ($56.33X10^4$ cfu g^{-1}, $56.67X10^4$ cfu g^{-1} and $57.33X10^4$ cfu g^{-1}) during the crop growing period whereas the inorganic treatments recorded the minimum. Maximum count of bacteria was seen in T_8 (Beejamrutham + Jeevamrutham + Mulching) ($48.67X10^5$ cfu g^{-1}, $53X10^5$ cfu g^{-1} and $44.67X10^5$ cfu g^{-1}) during the entire period of crop growth. The treatment receiving PM + Neem cake (T_7) recorded maximum actinomycetes population ($78\ X10^6$cfu g^{-1}, $79.33X10^6$ cfu g^{-1} and $68.67X10^6$ cfu g^{-1}) in all the stages of the crop growth. As the pH increased the microbial population was gradually increased. All the microorganisms were minimum in the treatment receiving fertilizers.

Table 1. Soil pH and EC as influenced by different treatments

Treatments	pH	EC (dS m^{-1})
T_1 (POP)	4.92	0.011
T_2 (FYM alone)	5.11	0.011
T_3 (N P K alone)	4.91	0.011
T_4 (PM)	5.21	0.012
T_5 (PM + N P K)	5.21	0.012
T_6 (Adhoc POP)	5.21	0.013
T_7 (PM + NC)	5.22	0.011
T_8 (Beejamruth+ Jeevamruth + Mulching)	4.91	0.011
T_9 (T_8 + PM)	5.62	0.011
T_{10} (PM + Beejamruth + Jeevamruth+ Without mulching)	5.10	0.011
T_{11} (PM + Panchagavyam)	5.01	0.011
T_{12} (PM + Fish amino acid)	5.51	0.011
T_{13} (Control)	4.70	0.011
CD (P= 0.05)	**0.98**	**0.99**
Initial value	4.51	0.011

Table 2. Organic carbon, nitrogen, phosphorus and potassium content of soil as influenced by different treatments

Treatments	OC (%)	N (kg/ha)	P (kg/ha)	K (kg/ha)
T_1 (POP)	1.30	526.12	30.44	305.96
T_2 (FYM alone)	1.31	497.50	25.27	261.67
T_3 (N P K alone)	1.21	510.88	28.76	283.47
T_4 (PM)	1.22	499.02	25.57	262.87
T_5 (PM + N P K)	1.24	528.66	30.77	312.15
T_6 (Adhoc POP)	1.44	534.00	31.37	314.95
T_7 (PM + NC)	1.37	516.17	27.99	278.13
T_8 (Beejamruth+ Jeevamruth + Mulching)	1.40	507.06	27.12	269.46
T_9 (T_8 + PM)	1.32	507.24	26.54	270.23
T_{10} (PM + Beejamruth +Jeevamruth+ Without mulching)	1.35	510.51	26.52	270.60
T_{11} (PM + Panchagavyam)	1.30	512.44	26.76	271.53
T_{12} (PM + Fish amino acid)	1.32	519.40	28.84	283.02
T_{13} (Control)	1.20	488.57	24.19	240.70
CD (P=0.05)	**0.05**	**2.45**	**0.69**	**3.22**
Initial value	1.2	486.0	24.00	239.40

Table 3. Total microbial population in soil as influenced by different treatments

Treatments	Fungal count (X 10^4 cfu /g)			Bacterial count (X 10^5 cfu /g)			Actinomycetes count (X 10^6 cfu /g)		
	15 DAS	30 DAS	Harvest	15 DAS	30 DAS	Harvest	15 DAS	30 DAS	Harvest
T_1 (POP)	31^{h}	34^{ef}	32.33^{e}	30.33^{b}	31.67^{f}	31.33^{f}	63.67^{d}	60.33^{g}	59.67^{e}
T_2 (FYM alone)	29.33^{i}	35^{def}	32.67^{e}	40.33^{de}	38.67^{e}	38^{e}	62.33^{d}	64.67^{e}	64^{b}
T_3 (N P K alone)	39.33^{d}	39.33^{c}	37.67^{d}	39^{ef}	41^{d}	35.33^{f}	60.33^{e}	60.67^{g}	61.33^{c}
T_4 (PM)	37.67^{e}	37.67^{cd}	37.33^{d}	39.33^{ef}	42^{d}	36^{b}	64^{d}	64.33^{d}	61^{c}
T_5 (PM + N P K)	33^{fg}	$32.67f^{g}$	33^{e}	37.33^{g}	41.33^{d}	35.67^{de}	63.67^{d}	63.33^{f}	61.33^{c}
T_6 (Adhoc POP)	37.67^{e}	38.67^{c}	36.33^{d}	46^{b}	47.67^{c}	41^{b}	76.33^{ab}	77^{b}	61.33^{c}
T_7 (PM + NC)	36.67^{e}	36.67^{cde}	37.33^{d}	39^{f}	48.33^{c}	34.67^{e}	78^{a}	79.33^{a}	68.67^{a}
T_8 (Beejamruth+ Jeevamruth + Mulching)	54.67^{b}	55^{a}	53.67^{b}	48.67^{a}	53^{a}	44.67^{a}	70.33^{c}	71.67^{d}	68.67^{a}
T_9 (T_8 + PM)	56.33^{ab}	56.67^{a}	57.33^{a}	45^{b}	50.33^{b}	40.67^{b}	70.33^{c}	71^{d}	61^{c}
T_{10} (PM + Beejamruth + Jeevamruth+ Without mulching)	47.33^{c}	48.33^{b}	42.33^{c}	40^{ef}	50.67^{b}	38.67^{c}	71.67^{c}	71^{d}	60.33^{c}
T_{11}(PM + Panchagavya)	32^{gh}	32.33^{fg}	32.33^{e}	42.33^{c}	51^{b}	41^{b}	75.33^{b}	76.67^{b}	60^{c}
T_{12} (PM + Fish amino acid)	31^{h}	30.33^{g}	30.67^{f}	$41.33c^{d}$	48.67^{c}	40.33^{b}	70.67^{c}	74^{c}	60^{c}
T_{13} (Control)	29.33^{i}	32.33^{fg}	30.67^{f}	29^{i}	30^{g}	30.67^{f}	59^{e}	59.67^{g}	60.67^{c}
Initial value	**33**			**29**			**61**		

4.3 GROWTH CHARACTERS

4.3.1 Germination percentage

The details of germination percentage on 4 and 7 DAS are presented in Table 4.The treatment receiving FYM alone (T_2) recorded the maximum percentage of germination (30%) followed by T_{12} (25%) on 4 DAS. None of the seeds has been germinated in T_9, T_{10} and T_{11} during the first 4 DAS. On 7 DAS, the highest percentage of germination was recorded in T_2 (FYM alone) followed by T_6 (Adhoc POP). T_{12} recorded the minimum percentage of germination (50.98 %). The seeds in the treatments T_2, T_4, T_6, T_7, T_{11} and T_{12} were treated with *Azospirillum*, Phosphate solubilising bacteria and *Pseudomonas*. All the treatments receiving FYM as basal dose along with seed treatment with *Azospirillum*, Phosphate solubilizing bacteria and *Pseudomonas* have shown early germination and seedling vigour.

4.3.2 Length of vines

The data presented in Table 5 shows the effect of different treatments on length of vines of cucumber recorded at 15 days interval. It is seen that there was significant difference in vine length among the treatments at all the stages of growth.

T_2 (FYM alone) recorded maximum vine length (4.48 cm) which was on par with T_6, T_{12} and T_1 on 15 DAS. The control (T_{13}) plot has recorded the minimum length of 1.95 cm.

T_6 (Adhoc POP) recorded maximum vine length of 79.52 cm on 30 DAS but was on par with T_{10},T_2,T_4,T_{12},T_{11} and T_5. The control plot recorded the minimum of 20.87 cm.

T_5 recorded maximum vine length on 45 DAS (185.00 cm) and was on par with T_{10} and T_{12} .The minimum of 102.93 cm was seen in the control plants (T_{13}).

Table 4. Percentage of germination as influenced by different treatments

Treatments	Germination %	
	4DAS	7DAS
T_1 (POP)	8.33	79.67
T_2 (FYM alone)	30.00	90.00
T_3 (N P K alone)	8.33	81.67
T_4 (Poultry manure)	16.67	47.50
T_5 (Poultry manure + N P K)	0.00	47.83
T_6 (Adhoc POP)	8.33	84.25
T_7 (Poultry manure + Neem cake)	8.33	76.00
T_8 (Beejamruthm + Jeevamruthm + Mulching)	12.50	64.83
T_9 (T_8 + Poultry manure)	0.00	60.17
T_{10} (Poultry manure + Beejamrutham + Jeevamrutham + Without mulching)	0.00	63.00
T_{11} (Poultry manure + Panchagavyam)	0.00	57.58
T_{12} (Poultry manure + Fish amino acid)	25.00	50.98
T_{13} (Control)	16.67	57.17
CD (P=0.05)	**3.20**	**0.324**

Table 5. Length of vine as influenced by different treatment

Treatments	Length of vine		
	15 DAS	30 DAS	45 DAS
T_1 (POP)	3.46	32.28	117.52
T_2 (FYM alone)	4.48	77.89	138.78
T_3 (N P K alone)	2.64	41.23	118.17
T_4 (Poultry manure)	2.84	74.35	159.59
T_5 (Poultry manure + N P K)	2.70	57.67	185.00
T_6 (Adhoc POP)	4.01	79.52	116.18
T_7 (PM + NC)	2.97	54.07	132.77
T_8 (Beejamruthm + Jeevamruthm + Mulching)	2.54	28.34	115.92
T_9 (T_8 + Poultry manure)	3.00	54.35	127.15
T_{10} (Poultry manure + Beejamrutham +Jeevamrutham+Without mulching)	2.82	78.55	182.52
T_{11} (Poultry manure + Panchagavyam)	3.70	65.08	132.48
T_{12} (Poultry manure + Fish amino acid)	2.56	71.68	180.99
T_{13} (Control)	1.95	20.87	102.93
CD (P=0.05)	**1.18**	**21.86**	**35.63**

4.3.3 Number of leaves

Data furnished in Table 6 indicates the number of leaves at 15 days interval. It shows that there was significant difference in the number of leaves among the treatments at all the stages of growth.

T_6 (Adhoc POP) and T_{10} (PM + Beejamrutham + Jeevamrutham) recorded the maximum number of leaves (5.32) on 15 DAS while T_3 (control) recorded the minimum.

T_{10} (PM + Beejamrutham + Jeevamrutham) had the maximum number of leaves (25.67) on 30 DAS which was on par with T_6, T_7, T_{12}, T_4 and T_{11}.The treatment receiving T_{13} (control) recorded the minimum number of leaves (9.41).

T_{12} (PM + Fish amino acid) recorded maximum number of leaves (73.22) at 45 DAS followed by T_1 and T_{11}. The control plots recorded the minimum number of leaves of 40.58.

4.3.4 Number of branches

Table 7 presents the data on number of branches. It shows that there was significant difference in the number of branches among the treatments, at all stages of growth.

On 30 DAS, T_6 (Adhoc POP) and T_{10} recorded the maximum number of branches plant^{-1} (2.67), followed by T_{12} and T_4 which were on par. T_{13} recorded the minimum number of branches (0.63).

On 45 DAS T_{12} (PM + Fish amino acid) recorded the highest number of branches plant^{-1}(5.74) which were on par with T_{10}, T_{11},T_1, ,T_4 and T_5. The treatment receiving T_{13} (control) recorded the minimum number of branches (2.48).

Table 6. Number of leaves as influenced by different treatments

Treatments	Number of leaves		
	15 DAS	30 DAS	45 DAS
T_1 (POP)	4.22	14.69	65.15
T_2 (FYM alone)	4.21	20.44	60.44
T_3 (N P K alone)	2.78	16.44	61.22
T_4 (Poultrymanure)	3.96	22.04	64.59
T_5 (Poultry manure + N P K)	4.54	21.07	56.55
T_6 (Adhoc POP)	5.32	24.52	46.63
T_7 (PM + NC)	4.71	22.81	55.45
T_8 (Beejamruthm + Jeevamruthm + Mulching)	3.04	19.00	56.52
T_9 (T_8 + Poultry manure)	4.79	21.04	56.63
T_{10} (Poultry manure + Beejamrutham + Jeevamrutham + Without mulching)	5.32	25.67	64.00
T_{11} (Poultry manure + Panchagavyam)	4.68	22.55	65.15
T_{12} (Poultry manure + Fish amino acid)	4.57	21.82	73.22
T_{13} (Control)	3.32	9.41	40.58
CD (P=0.05)	**0.161**	**6.40**	**7.75**

Table 7. Number of branches as influenced by different treatments

Treatments	Number of branches	
	(30 DAS)	**(45 DAS)**
T_1 (POP)	2.29	5.41
T_2 (FYM alone)	2.22	5.00
T_3 (N P K alone)	0.67	5.07
T_4 (PM)	2.45	5.33
T_5 (PM + N P K)	2.33	5.33
T_6 (Adhoc POP)	2.67	4.89
T_7 (PM + NC)	2.26	5.26
T_8 (Beejamruth+ Jeevamruth + Mulching)	2.19	4.67
T_9 (T_8 + PM)	2.33	5.04
T_{10} (PM + Beejamruth + Jeevamruth+ Without mulching)	2.67	5.67
T_{11} (PM + Panchagavyam)	2.37	5.48
T_{12} (PM + Fish amino acid)	2.47	5.74
T_{13} (Control)	0.63	2.48
CD (P=0.05)	**0.87**	**0.62**

4.3.5 Dry matter production

The DMP at different growth stages of cucumber is furnished in Table 8. It shows that there was significant difference among the treatments at all the stages of growth.

Among the treatments T_6 (Adhoc POP) registered the highest DMP of 52.33 g plant^{-1} on 30DAS while T_{13} recorded the lowest DMP of 8.6 g plant^{-1}.

The DMP on 60 DAS was the maximum for T_6 (116.30 g plant^{-1}) and the minimum in T_{13} (38.67g plant^{-1}) .

The same trend was noticed at harvest also. T_6 had the highest dry matter content of 136.00g plant^{-1}.

4.4 PHYSIOLOGICAL CHARACTERS

4.4.1 Chlorophyll content

Chlorophyll content (a, b and total) presented in Table 9 reveals that there is a significant variation among the treatments. T_6 recorded highest value of chlorophyll a (0.68 mg g^{-1}, 0.69 mg g^{-1} and 0.68 mg g^{-1}) on all the stages of the crop. The same trend was observed in the case of chlorophyll b and total chlorophyll. The values of chlorophyll b was the highest for T_6 being 0.14 mg g^{-1}, 0.15 mg g^{-1} and 0.14 mg g^{-1}. Total chlorophyll was 0.82 mg g^{-1}, 0.84 mg g^{-1} and 0.82 mg g^{-1}, respectively on 15 DAS, 30 DAS and at harvest. The treatment receiving liquid manure application also resulted in higher chlorophyll content. The control plot recorded lowest value during the crop growth period.

Table 8. Dry matter production as influenced by different treatments

Treatments	Dry matter production (g / plant)		
	30 DAS	**60 DAS**	**Harvest**
T_1 (POP)	37.67	50.33	56.00
T_2 (FYM alone)	12.33	40.67	49.53
T_3 (N P K alone)	11.33	39.33	42.50
T_4 (PM)	29.00	80.00	85.17
T_5 (PM + N P K)	13.67	49.00	53.83
T_6 (Adhoc POP)	92.33	116.30	136.00
T_7 (PM + NC)	35.67	90.00	101.60
T_8 (Beejamrutham+ Jeevamruth + Mulching)	31.00	48.00	50.13
T_9 (T_8 + PM)	47.33	113.33	115.63
T_{10} (PM + Beejamruth + Jeevamruth+ Without mulching)	40.00	54.00	64.33
T_{11} (PM + Panchagavyam)	36.33	78.33	98.83
T_{12} (PM + Fish amino acid)	33.33	100.00	106.03
T_{13} (Control)	8.60	38.67	44.13
CD (P=0.05)	**4.33**	**2.26**	**4.44**

Table 9. Chlorophyll content (mg/g) as influenced by different treatments

Treatments	Chlorophyll a			Chlorophyll b			Total		
	15DAS	30DAS	Harvest	15DAS	30DAS	Harvest	15DAS	30DAS	Harvest
T_1 (POP)	0.53	0.54	0.53	0.09	0.11	0.09	0.62	0.65	0.62
T_2 (FYM alone)	0.55	0.56	0.55	0.11	0.09	0.08	0.66	0.65	0.63
T_3 (N P K alone)	0.55	0.55	0.55	0.08	0.09	0.08	0.63	0.64	0.63
T_4 (PM)	0.54	0.55	0.54	0.08	0.09	0.08	0.62	0.64	0.62
T_5 (PM + N P K)	0.56	0.57	0.56	0.08	0.09	0.08	0.64	0.66	0.64
T_6 (Adhoc POP)	0.68	0.69	0.68	0.14	0.15	0.14	0.82	0.84	0.82
T_7 (PM + NC)	0.53	0.54	0.53	0.09	0.09	0.08	0.62	0.75	0.74
T_8 (Beejamrutham+ Jeevamrutham + Mulching)	0.66	0.67	0.66	0.09	0.09	0.08	0.75	0.76	0.74
T_9 (T_8 + PM)	0.65	0.65	0.66	0.09	0.09	0.08	0.74	0.73	0.74
T_{10} (PM + Beejamruth + Jeevamruth + Without mulching)	0.66	0.67	0.66	0.09	0.09	0.08	0.75	0.75	0.74
T_{11} (PM + Panchagavyam)	0.66	0.66	0.65	0.13	0.13	0.12	0.79	0.78	0.77
T_{12} (PM + Fish amino acid)	0.65	0.66	0.65	0.12	0.13	0.12	0.77	0.78	0.77
T_{13} (Control)	0.49	0.48	0.48	0.06	0.06	0.05	0.55	0.53	0.53
CD (P=0.05)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

4.4.2 Leaf Area Index

The data on LAI is presented in Table 10. T_{11} (PM + Panchagavya) recorded the highest value of LAI on 15 DAS (3.90) which was on par with T_6 and T_9. The same trend was observed on 30 DAS T_{11} obtained a LAI of 4.03 on 30 DAS. On 45 DAS, T_{11} had a LAI of 4.23 followed by T_6 and T_1 . T_{13} recorded the lowest leaf area index at all stages of growth.

4.5 YIELD AND YIELD ATTRIBUTES

4.5.1 Days to first flower opening

The data on days to flower opening is given in the Table 11. It reveals that the treatment receiving PM + FAA (T_{12}) showed the trend of early flowering. The first female flower appeared on 27 DAS which was on par with T_{11} and T_7 (28 DAS). The control plot and the treatment receiving NPK alone took more days to flower (47 and 38 days, respectively).

4.5.2 Number of fruits plant^{-1}

Data on the effect of treatments on number of fruits plant^{-1} is presented in Table 12. It shows that there was significant difference in the number of fruits among the treatments. T_6 (Adhoc POP) recorded the maximum number of fruits (23.33) which was significantly higher than all other treatments. The control plot recorded the minimum of 7.33.

4.5.3 Weight of fruits plant^{-1}

Data furnished in Table 12 showed significant variation among treatments in the weight of fruits plant^{-1}.T_6 (Adhoc POP) recorded the maximum weight of fruits (16.59 kg plant^{-1}) and was significantly superior to other treatments. T_{13} (control) recorded lowest weight of 1.87 kg plant^{-1}.

Table 10. Leaf area index as influenced by different treatments

Treatments	Leaf Area Index		
	(15 DAS)	(30 DAS)	(45 DAS)
T_1 (POP)	3.47	3.63	3.90
T_2 (FYM alone)	2.77	3.00	3.26
T_3 (N P K alone)	3.00	3.10	3.46
T_4 (PM)	2.93	3.16	3.33
T_5 (PM + N P K)	3.13	3.23	3.50
T_6 (Adhoc POP)	3.76	3.93	4.06
T_7 (PM + NC)	3.30	3.43	3.66
T_8 (Beejamruth+ Jeevamruth + Mulching)	3.26	3.40	3.66
T_9 (T_8 + PM)	3.66	3.83	3.03
T_{10} (PM + Beejamruth + Jeevamruth + Without mulching)	3.46	3.66	3.80
T_{11} (PM + Panchagavyam)	3.90	4.03	4.23
T_{12} (PM + Fish amino acid)	3.50	3.66	3.83
T_{13} (Control)	1.43	1.70	1.93
CD (P=0.05)	**0.33**	**0.36**	**0.42**

Table 11. Days to flowering as influenced by different treatments

Treatments	Days to 1st flower opening
T_1 (POP)	32.66
T_2 (FYM alone)	37.33
T_3 (N P K alone)	38.00
T_4 (PM)	31.33
T_5 (PM + N P K)	32.33
T_6 (Adhoc POP)	29.33
T_7 (PM + NC)	28.66
T_8 (Beejamruth+ Jeevamruth + Mulching)	30.66
T_9 (T_8 + PM)	30.33
T_{10} (PM + Beejamruth + Jeevamruth+ Without mulching)	32.66
T_{11} (PM + Panchagavyam)	28.33
T_{12} (PM + Fish amino acid)	27.33
T_{13} (Control)	47.00
CD	**1.39**

Table 12. Number of fruits, weight of fruits and length of fruits as influenced by different treatments

Treatments	No of fruits/plant	Weight of fruits (kg)	Length of fruits (cm)
T_1 (POP)	21.67	14.91	21.67
T_2 (FYM alone)	17.33	11.57	14.00
T_3 (N P K alone)	15.33	6.39	20.83
T_4 (PM)	18.00	8.38	21.00
T_5 (PM + N P K)	21.67	7.44	23.07
T_6 (Adhoc POP)	23.33	16.59	26.56
T_7 (PM + NC)	21.00	8.79	20.67
T_8 (Beejamruth+ Jeevamruth + Mulching)	20.00	8.11	22.99
T_9 (T_8 + PM)	18.00	13.62	21.18
T_{10} (PM + Beejamruth + Jeevamruth+Without mulching)	18.33	8.46	25.89
T_{11} (PM + Panchagavyam)	16.00	6.31	18.80
T_{12} (PM + Fish amino acid)	21.67	11.43	27.88
T_{13} (Control)	7.33	1.87	12.11
CD (P=0.05)	**0.19**	**0.68**	**1.09**

4.5.4 Length of fruits per plant

Data on the length of fruits plant^{-1} (Table12) shows that there was significant difference with regard to different treatments.The maximum fruit length of 27.88 cm was registered in T_{12} and the minimum (12.11 cm) in the control plants.

4.5.5 Yield

Statistical analysis of data (Table 13) revealed that the different treatments had a significant influence on yield of cucumber. The highest yield of 53.94 t ha^{-1} was obtained in the treatment receiving Adhoc POP *ie.*, FYM+ vermi compost + cowdung slurry (T_6) followed by POP recommendation (T_1) being 48.44 t ha^{-1}. The treatment receiving T_{13} (control) has recorded the minimum yield of 6.11 t ha^{-1}. The organic manure application has improved the yield attributes in general.

4.5.6 Number of harvest

The organic treatments appreciably influenced the number of harvest as evident from Table 13. It is seen that there was significant difference in number of harvest among the treatments.

T_6 (Adhoc POP) recorded maximum number of harvest (15.09) which was on par with T_1. The control plots (T13) and fertilizer treated plots (T3) recorded the lesser number of harvest (4.94 and 9.89 respectively).

4.5.7 Duration of the crop

The data on total crop duration furnished in Table 13 revealed that there was significant difference with regard to crop duration among the different treatments. T_{12} (PM + Fish amino acid) recorded the maximum crop duration of 97.66 days followed by T_6 (95.33 days). The minimum of 70 days was seen in the control plots.

Table 13. Yield, number of harvest and duration of the crop as influenced by different treatments

Treatments	Yield (t/ ha)	No. of harvest	Duration of the crop (days)
T_1 (POP)	48.44	14.40	89.33
T_2 (FYM alone)	37.60	12.00	77.66
T_3 (N P K alone)	20.76	9.89	77.33
T_4 (PM)	27.23	13.20	83.66
T_5 (PM + N P K)	24.18	13.10	88.33
T_6 (Adhoc POP)	53.94	15.09	95.33
T_7 (PM + NC)	28.57	12.33	88.00
T_8 (Beejamruth+ Jeevamruth + Mulching)	26.36	12.86	86.66
T_9 (T_8 + PM)	24.25	11.93	85.00
T_{10} (PM + Beejamruth + Jeevamruth + Without mulching)	27.50	12.26	85.66
T_{11} (PM + Panchagavyam)	26.49	12.33	89.00
T_{12} (PM + Fish amino acid)	37.14	13.94	97.66
T_{13} (Control)	6.11	4.94	70.00
CD (P=0.05)	**2.20**	**0.901**	**1.79**

4.5.8 Days to first harvest

The data presented in Table 14 indicates that early harvesting could be done from the plants receiving PM + FAA (T_{12}). The first harvest was taken from T_{12} on 35 DAS. T_6, T_9 and T_{10} also took minimum number of days to first harvest. The plants in T_1 (POP) could be harvested only on 45th DAS. Control plots took maximum number of days (53.66) for first harvest.

4.5.9 Fruit flesh thickness

The data on fruit flesh thickness is furnished in Table 15. It is seen that there was significant difference in fruit flesh thickness among the treatments.

T_6 (Adhoc POP) recorded maximum fruit flesh thickness (2.17cm). T_{11}, T_4, T_9, and T_{12} and were on par with each other.T_3 recorded the lowest fruit flesh thickness of 0.86 cm.

4.5.10 Number of seeds fruit^{-1}

A perusal of data on number of seeds fruit^{-1} in Table 15 reveals the superiority of T_6 (Adhoc POP) with maximum number of seeds fruit^{-1}(676) whereas the POP (T_1) realized 644.33 numbers. The treatment receiving T_{13} recorded minimum number of seeds fruit^{-1} (203.33).

4.5.11 Uptake of Nitrogen

The uptake of nitrogen by plant after harvest of cucumber is furnished in Table 16. The highest value of nitrogen uptake (40.81 kg ha^{-1}) was recorded in T_6 (Adhoc POP) followed by T_5 (38.26 kg ha^{-1}). The minimum of 15.07 kg ha^{-1} was seen in the control plants.

4.5.12 Uptake of Phosphorus

The data given in Table 16 clearly depicts the significant influence of treatments on phosphorus uptake of plant at harvest. T_5 (PM + NPK) recorded the maximum P uptake (6.54 kg ha^{-1}) and on par with T_1 (6.48 kg ha^{-1}) and

T_6 (6.41 kg ha^{-1}). The treatment receiving T_{13} (control) has recorded the minimum content of 1.04 kg ha^{-1}.

4.5.13 Uptake of Potassium

Various treatments significantly influenced the potassium uptake of plants at harvest (Table 16) .The highest potassium uptake was recorded in T_5 (42.55 kg ha^{-1}) and was on par with T_1 and T_6. The lowest content was recorded by T_{13} (18.24 kg ha^{-1}).

4.6 QUALITY ATTRIBUTES

4.6.1 Organoleptic test

The data pertaining to organoleptic test is furnished in Table 17. Statistical analysis by Kendall's test by ranks of the acceptability score revealed that there was significant variation among the treatments in the quality attributes of fruits. The highest score for appearance (10.68) had been recorded by the treatment (T_{11}) receiving panchagavyam as foliar spray. The maximum score for colour (11.10) was also recorded for the same treatment followed by T_{12} (the treatment receiving fishamino acid as foliar spray). The lowest score for colour was recorded by the treatment receiving chemical fertilizers. The scores for flavor, texture, odour and taste were also more for the treatment receiving panchagavyam as foliar spray. The overall acceptability was more for the organic treatments. The judges have specifically remarked on the difference in the taste of fruits produced from the fertilizer treated plots. Among the organic sources, FYM, vermi compost and poultry manure treated plots produced fruits having the best organoleptic qualities among which poultry manure with panchagavyam stood first.

Table 14. Days to first harvest as influenced by different treatments

Treatments	Days to 1st harvest
T_1 (POP)	44.66
T_2 (FYM alone)	44.33
T_3 (N P K alone)	48.66
T_4 (PM)	46.33
T_5 (PM + N P K)	47.33
T_6 (Adhoc POP)	38.33
T_7 (PM + NC)	40.66
T_8 (Beejamruth+ Jeevamruth + Mulching)	42.00
T_9 (T_8 + PM)	36.33
T_{10} (PM + Beejamruth + Jeevamruth+ Without mulching)	38.66
T_{11} (PM + Panchagavyam)	40.66
T_{12} (PM + Fish amino acid)	35.33
T_{13} (Control)	53.66
CD (P=0.05)	**0.99**

Table 15. Number of seeds per fruit and fruit flesh thickness of the crop as influenced by different treatments

Treatments	No of seeds fruit^{-1}	Fruit flesh thickness (cm)
T_1 (POP)	644.33	1.89
T_2 (FYM alone)	342.33	1.71
T_3 (N P K alone)	498.00	0.86
T_4 (PM)	227.00	2.00
T_5 (PM + N P K)	466.66	1.78
T_6 (Adhoc POP)	676.00	2.17
T_7 (PM + NC)	632.00	1.86
T_8 (Beejamruth+ Jeevamruth + Mulching)	553.66	1.88
T_9 (T_8 + PM)	491.33	2.00
T_{10} (PM + Beejamruth + Jeevamruth+ Without mulching)	593.00	1.72
T_{11} (PM + Panchagavyam)	610.33	2.02
T_{12} (PM + Fish amino acid)	393.33	2.00
T_{13} (Control)	203.33	1.89
CD (P=0.05)	**10.33**	**0.11**

Table 16. Nitrogen, phosphorus and potassium uptake by plant as influenced by different treatments

Treatments	Uptake (kg / ha)		
	N	P	K
T_1 (POP)	37.12	6.48	42.43
T_2 (FYM alone)	23.14	3.04	26.26
T_3 (N P K alone)	35.34	5.16	39.55
T_4 (PM)	26.21	3.98	26.29
T_5 (PM + N P K)	38.26	6.54	42.55
T_6 (Adhoc POP)	40.81	6.41	42.09
T_7 (PM + NC)	34.42	5.01	34.09
T_8 (Beejamruth+ Jeevamruth + Mulching)	32.07	4.63	29.09
T_9 (T_8 + PM)	32.28	4.65	30.08
T_{10} (PM + Beejamruth + Jeevamruth+ Without mulching)	32.54	4.72	30.06
T_{11} (PM + Panchagavyam)	33.26	4.81	31.78
T_{12} (PM + Fish amino acid)	36.23	5.12	36.17
T_{13} (Control)	15.07	1.05	18.24
CD (P=0.05)	**0.87**	**0.309**	**0.780**

Table 17. Quality of the produce as influenced by various treatments

Treatments	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability
T_1 (POP)	6.20	5.30	5.60	5.58	5.03	5.08	5.55	5.45
T_2 (FYM alone)	6.60	6.68	6.60	6.43	6.63	6.60	6.75	6.43
T_3 (N P K alone)	1.70	1.93	1.93	1.70	2.13	2.17	1.70	1.88
T_4 (PM)	5.83	6.10	5.73	5.90	6.18	5.70	5.85	5.80
T_5 (PM + N P K)	7.30	7.18	7.20	7.10	7.75	7.65	7.25	7.43
T_6 (Adhoc POP)	8.10	7.28	7.90	8.15	7.65	7.63	8.00	8.45
T_7 (PM + NC)	6.58	7.03	6.65	6.70	6.88	6.60	6.73	6.48
T_8 (Beejamruth+ Jeevamruth + Mulching)	7.20	7.30	7.75	7.28	7.20	7.40	7.38	7.35
T_9 (T_8 + PM)	6.68	6.95	6.60	6.68	6.50	6.85	6.70	6.83
T_{10} (PM + Beejamruth + Jeevamruth+ Without mulching)	9.00	8.85	8.73	9.30	9.07	9.23	9.10	9.38
T_{11} (PM + Panchagavyam)	10.68	11.10	10.90	10.73	10.88	10.90	10.78	10.38
T_{12} (PM + Fish amino acid)	9.30	9.40	9.40	9.32	9.48	9.23	9.38	9.32
T_{13} (Control)	5.85	5.93	6.30	6.15	5.65	5.98	5.85	5.85
Kendall's W(a)	**0.325**	**0.329**	**0.325**	**0.340**	**0.330**	**0.325**	**0.339**	**0.331**

4.6.2 Shelf life of the crop

The data on shelf life of the crop is furnished in Table 18. It is seen that there was significant difference in shelf life among the treatments.

T_{12} (PM + Fish amino acid) recorded the maximum shelf life of about 8.47 days followed by 7.17 days in T_{11} (PM + FAA). The treatment receiving fertilizer alone (T_3) has recorded the minimum shelf life of 4.27 days while the control plot (T_{13}) recorded slightly higher shelf life of 4.75 days. The treatment receiving POP (T_1) recorded a shelf life of only 5.78 days.

4.7 INCIDENCE OF PESTS AND DISEASES

No severe attack of pests and diseases was observed in the experimental plots. The treatment receiving fertilizers (T_3) alone had aphid infestation during the early stages of the crop. Pumpkin beetle attack was also seen in the treatment T_5 (PM + N P K) and T_1 (POP). Beauveria, neem soap and garlic extract were sprayed in all the plots as and when required.

4.8 ECONOMIC ANALYSIS

The data on economic analysis is furnished in Table19. It is seen that there was significant difference in B:C ratio among the treatments. T_6 (Adhoc POP) was found to be significantly superior to other treatments with regard to gross income, net return and B:C ratio. The Adhoc POP (FYM + vermi compost + Cow dung slurry) achieved a B:C ratio above 2.55 while the present package of practices recommendation recorded the B:C ratio of only 2.20. The lowest net income (Rs. 15,450 ha $^{-1}$) and B:C ratio (1.20) was registered in T_{13} (Control).

Table 18. Shelf life of the crop as influenced by different treatments

Treatments	Shelf life of the crop (days)
T_1 (POP)	5.78
T_2 (FYM alone)	5.72
T_3 (N P K alone)	4.27
T_4 (PM)	5.54
T_5 (PM + N P K)	5.75
T_6 (Adhoc POP)	6.06
T_7 (PM + NC)	6.27
T_8 (Beejamruth+ Jeevamruth + Mulching)	6.37
T_9 (T_8 + PM)	6.79
T_{10} (PM + Beejamruth + Jeevamruth+ Without mulching)	6.85
T_{11} (PM + Panchagavyam)	7.17
T_{12} (PM + Fish amino acid)	8.47
T_{13} (Control)	4.75
CD (P=0.05)	**0.15**

Table 19. Total cost of cultivation, gross return, net return and B:C ratio as influenced by different treatments

Treatments	Total cost of cultivation (Rs)	Gross returns (Rs)	Net returns (Rs)	B : C ratio
T_1 (POP)	3,24,409	7,13,700	3,89,291	2.20
T_2 (FYM alone)	2,94,675	5,89,350	2,94,675	2.00
T_3 (N P K alone)	1,94,700	2,92,050	97,350	1.51
T_4 (PM)	2,84,972	4,26,150	1,41,178	1.49
T_5 (PM + N P K)	2,41,500	3,62,250.	1,20,750	1.50
T_6 (Adhoc POP)	3,80,075	9,70,920	4,80,124	2.55
T_7 (PM + NC)	2,84,962	4,27,800	1,42,838	1.50
T_8 (Beejamruth+ Jeevamruth + Mulching)	2,14,942	4,05,000	1,90,058	1.88
T_9 (T_8 + PM)	2,94,938	6,46,350	3,51,412	2.19
T_{10} (PM + Beejamruth + Jeevamruth+Without mulching)	2,53,938	4,25,100	1,71,162	1.68
T_{11} (PM + Panchagavyam)	2,08,700	3,13,050	1,04,350	1.50
T_{12} (PM + Fish amino acid)	2,85,422	5,53,800	2,68,378	1.94
T_{13} (Control)	77,250	92,700	15,450	1.20

Market price of cucumber – Rs 15 kg^{-1}

DISCUSSION

5. DISCUSSION

The experiment entitled "Nutrient management in organic farming of cucumber (*Cucumis sativus* L.)" was conducted during 2012-2013 in College of Horticulture, Vellanikkara. The results pertaining to the study have been discussed below.

5.1 Soil characters

Soil characters were significantly influenced by different treatments. The pH of the soil before the experiment was 4.51. The treatment receiving Poultry manure + *jeevamrutham* + *beejamrutham* + mulching recorded the highest pH (5.62) after the experiment (Fig.4). Application of organic manures including liquid manures might have contributed to the increase in pH (Lal *et al.*, 2000). The different treatments had no significant influence on soil EC. There was no change in the value of EC (0.011 dSm^{-1}) except in T_4, T_5, T_6 (Fig.5).

The initial organic carbon of soil of experimental area was 1.20%. After the experiment the value ranged from 1.20 in T_{13} to 1.44 % in T_6 (Fig.6). The increase in organic carbon content of soil under organic farming is quite obvious since the carbonaceous materials contribute to soil organic carbon after their decomposition. The same trend was observed by Hangarge *et al.* (2004). Mulching also increased the organic carbon content.

Application of organic amendments improved physical properties of the soil and balanced the nutrient availability to plants and boosted the production and quality of the crop. The living microbes mobilized nutritionally important elements to available form through biological process.

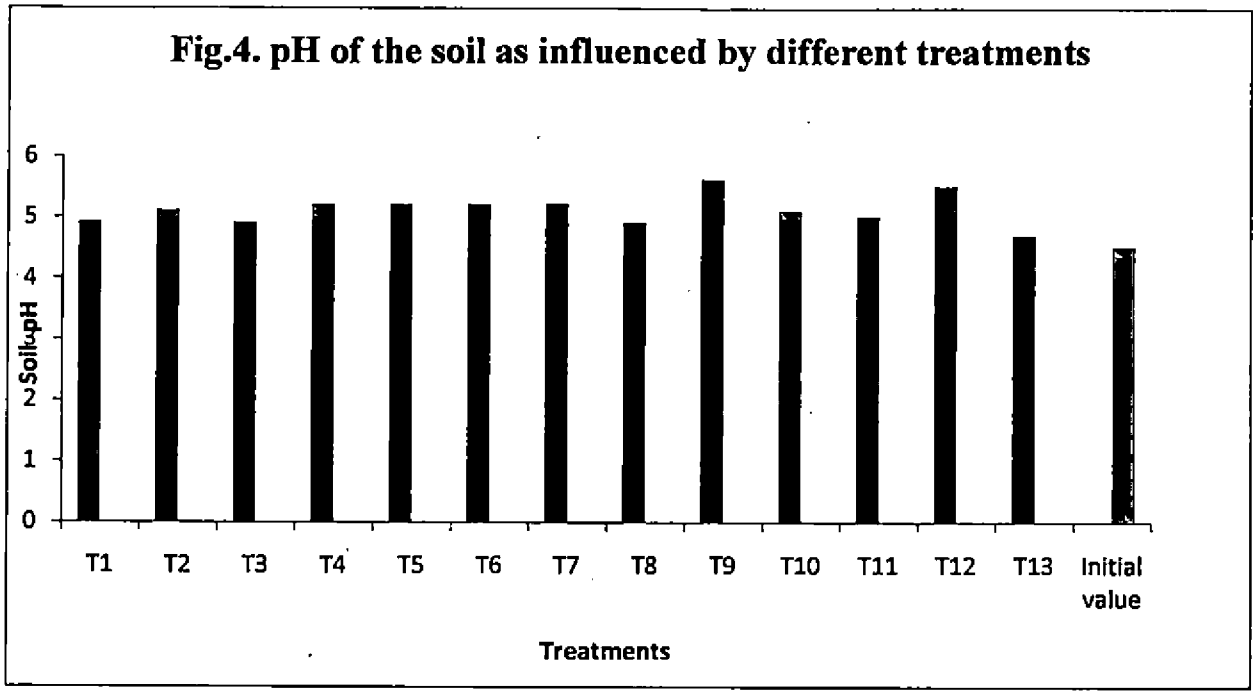
The available nitrogen content of soil after harvest of cucumber is furnished in Table 7. The highest available nitrogen content was recorded in T_6 (534.00 kg ha^{-1}) which was significantly superior to other treatments. The increase in available N is attributable to the greater multiplication of soil microbes due to the addition of organic materials, which mineralize organically bound N to available form. Application of Poultry manure stimulated the soil biological characteristics such as

CO_2 production, dehydrogenase activity and mineralization of organic nitrogen into NH_4^+ N and NO_3^- N as observed by Kara *et al* .(2007).

The data given in Fig.6 clearly depicts the significant influence of treatments on available phosphorus content in soil after the experiment.T_6 recorded the maximum P content (31.37 kg ha^{-1}). Increase in total and available P_2O_5 content in soil due to vermi compost application may be due to greater mineralization of organic matter with the aid of micro flora associated earth worms (Radhakrishnan, 2009). The major effect of vermi compost application in soil was the reduction in P fixation and thus increasing P availability in acid soils as reported by Baiju *et al.*(2009).

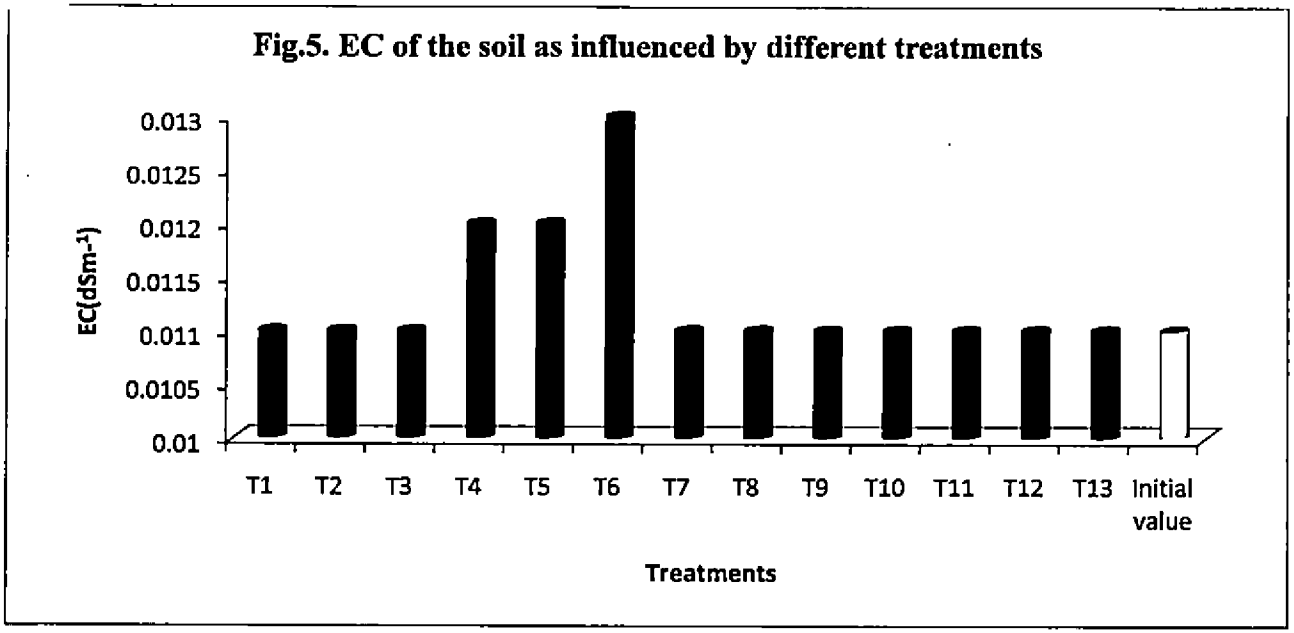
Various treatments significantly influenced the available potassium content of soil after harvest (Fig.7). The highest available potassium content was recorded in T_6 (314.96 kg ha^{-1}). Similar result was obtained by Magray *et al.* (2011) in tomato when cowdung slurry was applied.

Fig.4. pH of the soil as influenced by different treatments

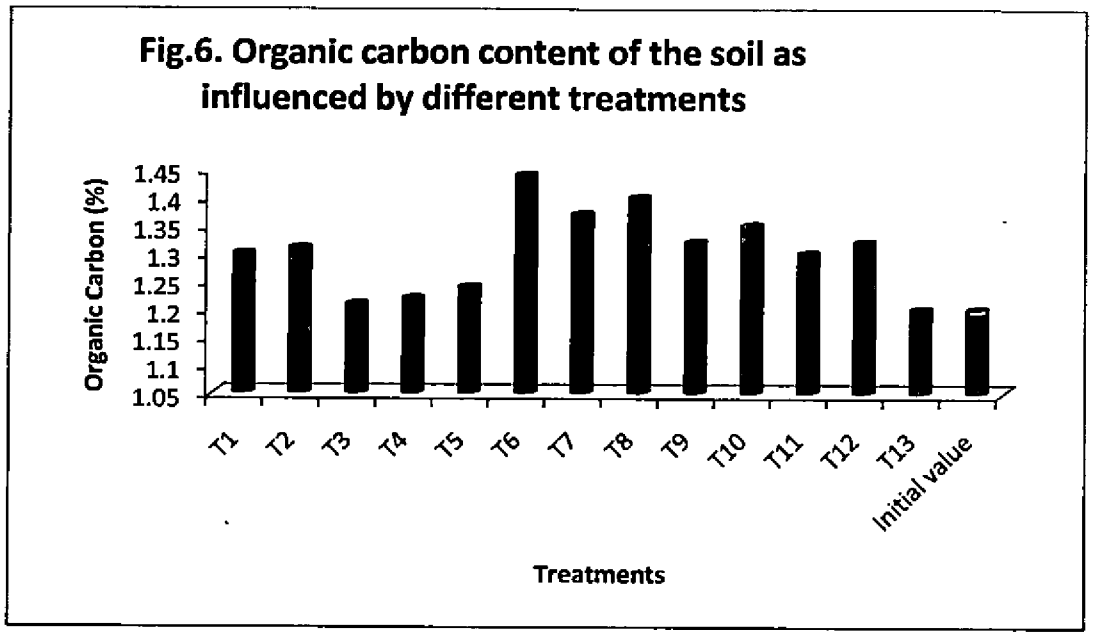


T_1 - POP
T_2 - FYM alone
T_3 - N P K alone
T_4 - PM
T_5 - PM + N P K
T_6 - Adhoc POP
T_7 - PM + NC
T_8 - *Beejamrutham* + *Jeevamrutham* + Mulching
T_9 - T8 + PM
T_{10} - PM + *Beejamrutham* + *Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam*
T_{12} - PM + Fish amino acid
T_{13} - Contro

Fig.5. EC of the soil as influenced by different treatments

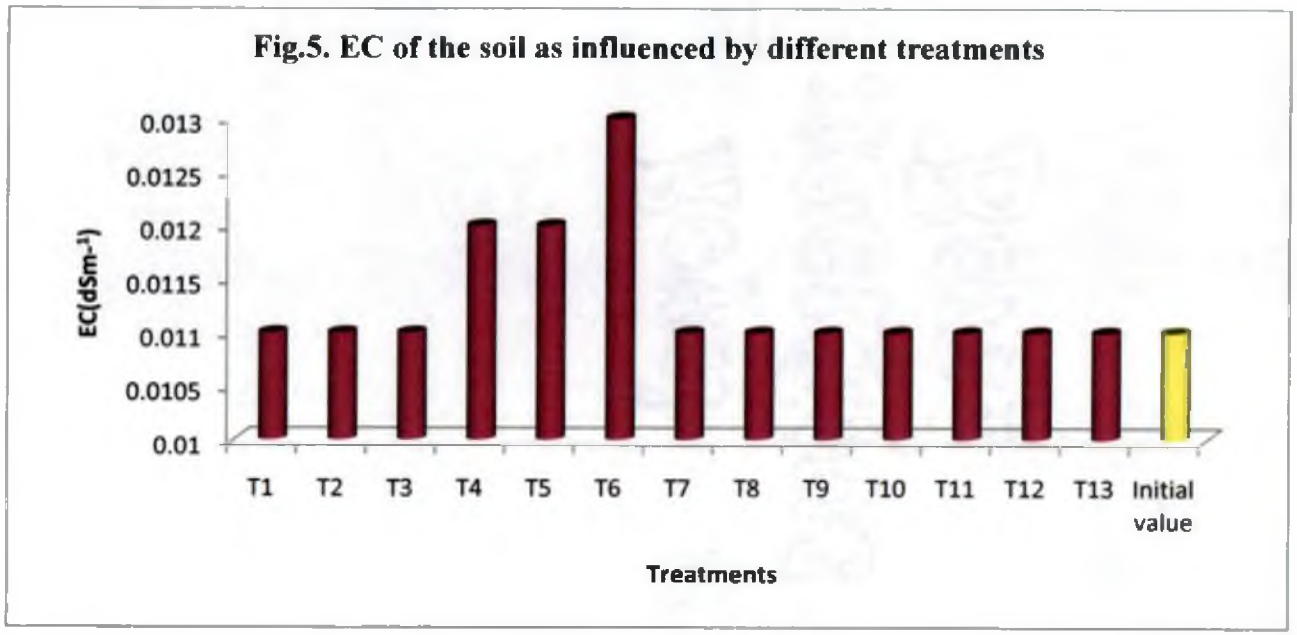


T_1 - POP T_2 - FYM alone
T_3 - N P K alone T_4 - PM
T_5 - PM + N P K T_6 - Adhoc POP
T_7 - PM + NC T_8 - *Beejamrutham* + *Jeevamrutham* +Mulching
T_9 - T8 + PM T_{10} - PM + *Beejamrutham* +*Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam* T_{12} - PM + Fish amino acid
T_{13} - Control



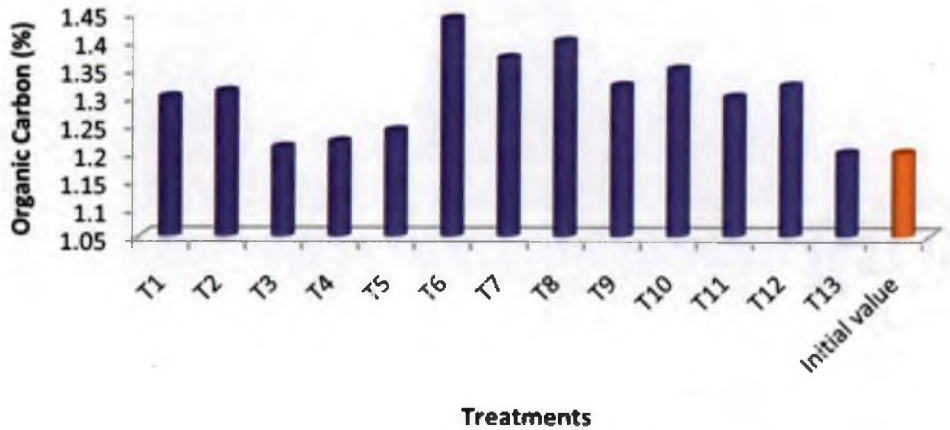
T_1 - POP
T_2 - FYM alone
T_3 - N P K alone
T_4 - PM
T_5 - PM + N P K
T_6 - Adhoc POP
T_7 - PM + NC
T_8 - *Beejamrutham* + *Jeevamrutham* + Mulching
T_9 - T8 + PM
T_{10} - PM + *Beejamrutham* + *Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam*
T_{12} - PM + Fish amino acid
T_{13} - Control

Fig.5. EC of the soil as influenced by different treatments



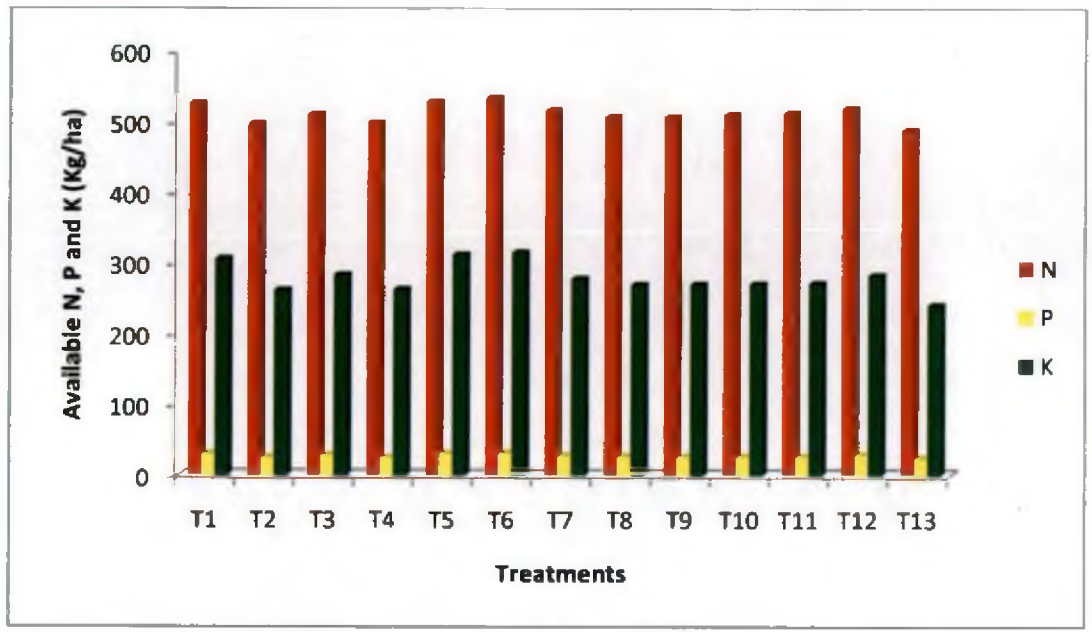
T_1 - POP T_2 - FYM alone
T_3 - N P K alone T_4 - PM
T_5 - PM + N P K T_6 - Adhoc POP
T_7 - PM + NC T_8 - *Beejamrutham* + *Jeevamrutham* +Mulching
T_9 - T8 + PM T_{10} - PM + *Beejamrutham* +*Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam* T_{12} - PM + Fish amino acid
T_{13} - Control

Fig.6. Organic carbon content of the soil as influenced by different treatments



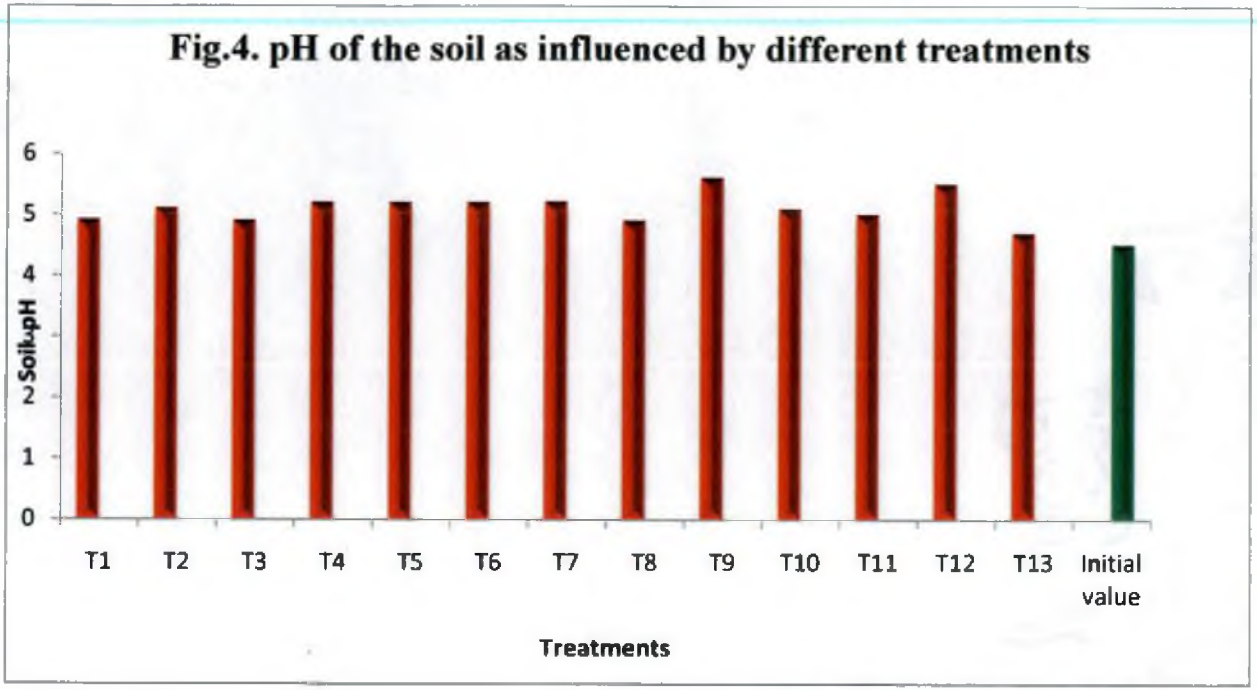
T_1 - POP
T_2 - FYM alone
T_3 - N P K alone
T_4 - PM
T_5 - PM + N P K
T_6 - Adhoc POP
T_7 - PM + NC
T_8 - *Beejamrutham* + *Jeevamrutham* + Mulching
T_9 - T8 + PM
T_{10} - PM + *Beejamrutham* + *Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam*
T_{12} - PM + Fish amino acid
T_{13} - Control

Fig.7. Available N, P and K content of the soil as influenced by different treatments



T_1 - POP T_2 - FYM alone
T_3 - N P K alone T_4 - PM
T_5 - PM + N P K T_6 - Adhoc POP
T_7 - PM + NC T_8 - *Beejamrutham* + *Jeevamrutham* +Mulching
T_9 - T8 + PM T_{10} - PM + *Beejamrutham* +*Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam* T_{12} - PM + Fish amino acid
T_{13} - Control

Fig.4. pH of the soil as influenced by different treatments



T_1 - POP
T_2 - FYM alone
T_3 - N P K alone
T_4 - PM
T_5 - PM + N P K
T_6 - Adhoc POP
T_7 - PM + NC
T_8 - *Beejamrutham* + *Jeevamrutham* + Mulching
T_9 - T8 + PM
T_{10} - PM + *Beejamrutham* + *Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam*
T_{12} - PM + Fish amino acid
T_{13} - Contro

5.2 Microbial population in soil

Different organic manuring treatments significantly increased the microbial population (fungi, bacteria and actinomycetes) in soil. Application of poultry manure and combined application FYM and vermi compost were found to be good for improving soil biological activity.

The initial population of fungus was $33X10^4$ cfu g^{-1} and that of bacteria was $29X10^5$ cfu g^{-1} in the soil. The population of actinomycetes was $61X10^6$ cfu g^{-1} of soil. The treatment receiving poultry manure + *Beejamrutham* + *Jeevamrutham* recorded 71 % increase in fungal population during the crop growing period. The bacterial population was 82% more in the treatment receiving *Beejamrutham* + *Jeevamrutham* + mulching. Poultry manure + neem cake applied treatment recorded 30% increase in actinomycetes population. Population of fungi, bacteria and actinomycetes were minimum in the treatment receiving fertilizers (Fig.8).

The maximum microbial population in the case of all organic treatments could be attributed to favourable effects of manures in proliferating microbial population by providing carbon as a source of energy for microbes and also protection to enzyme fraction due to increase in the humus content (Martens *et al* .,1992).The increase in soil pH also might have contributed favourable environment for the multiplication of microbes in treatments receiving organic manures. The lower bulk density also might have provided good aeration and there by good biological activity (Arun, 2004). Enormous amount of microbial load in *Jeevamrutham* might be multiplied in the soil contributing better crop growth and yield.The findings that the microbial properties and N availability for plants differed under different organic input regimes suggest the need for effective residue management in organic farming systems (Tu *et al* ., 2006).

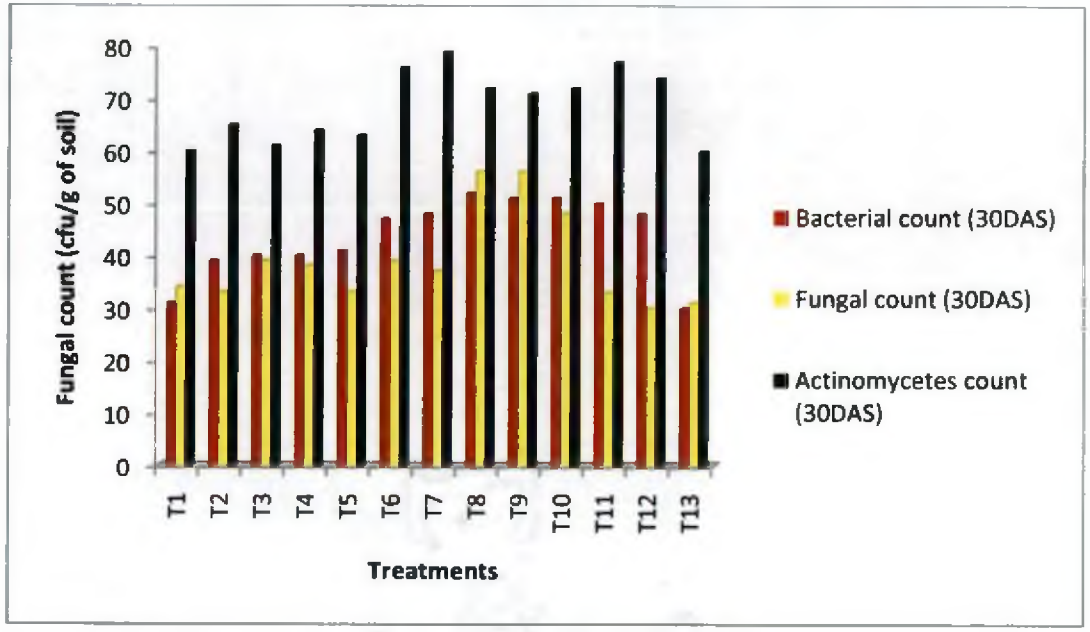
Poultry manure application will increase the dehydrogenase activity (ten times) which is a reliable indicator of soil microflora status. Before the organic nitrogen is used by the crops, it is converted through bacterial action into readily usable ammoniacal nitrogen and nitrate nitrogen. These organic manures are, therefore, relatively slow acting, but they supply available nitrogen for a longer period (Reddy and Reddy, 2005). Straw mulching enhanced microbial biomass, activity and potential N availability by 42, 64 and 30 %, respectively, relative to non-mulched soils, likely via improving C and water availability for soil microbes (Tu *et al.*,2006).

Application of organic manures at 10 days interval has enhanced the microbial activities in soil. The bulk density was low in soil under organic farming system than the soil under conventional farming system. Consequently the organic soils possessed good aeration and thereby good biological activity (Arun, 2004).

Palekar (2007) reported that *jeevamrutham* contains enormous amount of microbial load which when applied to soil multiplied in the soil and plants under such management put forth better growth and yield.

Mulching also had beneficial effects on soil microbes likely through buffering the extreme fluctuation in soil moisture and temperature (Erenstein, 2007). In addition, mulching provided other benefits through reducing soil erosion and nutrient losses and suppressing weeds, as weed control generally poses a major challenge in organic farming. Mulching was effective in sustaining soil microbial biomass and activity in our soils. These results indicated that the amount and quality of organic inputs could profoundly impart the microbial properties and N availability for plants, highlighting the need for effective residue management in organic farming systems (Erenstein, 2007). Different organic manuring treatments gave significantly higher microbial population (Fungi, bacteria and actinomycetes) and enzymatic activities in the soil and application of poultry manure, vermi compost and FYM in combination was good for improving soil quality (Ravisankar *et al.*,2008).

Fig.8. Total microbial count of the soil as influenced by different treatments



T_1 - POP
T_2 - FYM alone
T_3 - N P K alone
T_4 - PM
T_5 - PM + N P K
T_6 - Adhoc POP
T_7 - PM + NC
T_8 - *Beejamrutham* + *Jeevamrutham* +Mulching
T_9 - T8 + PM
T_{10} - PM + *Beejamrutham* +*Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam*
T_{12} - PM + Fish amino acid
T_{13} - Control

5.3 GROWTH CHARACTERS

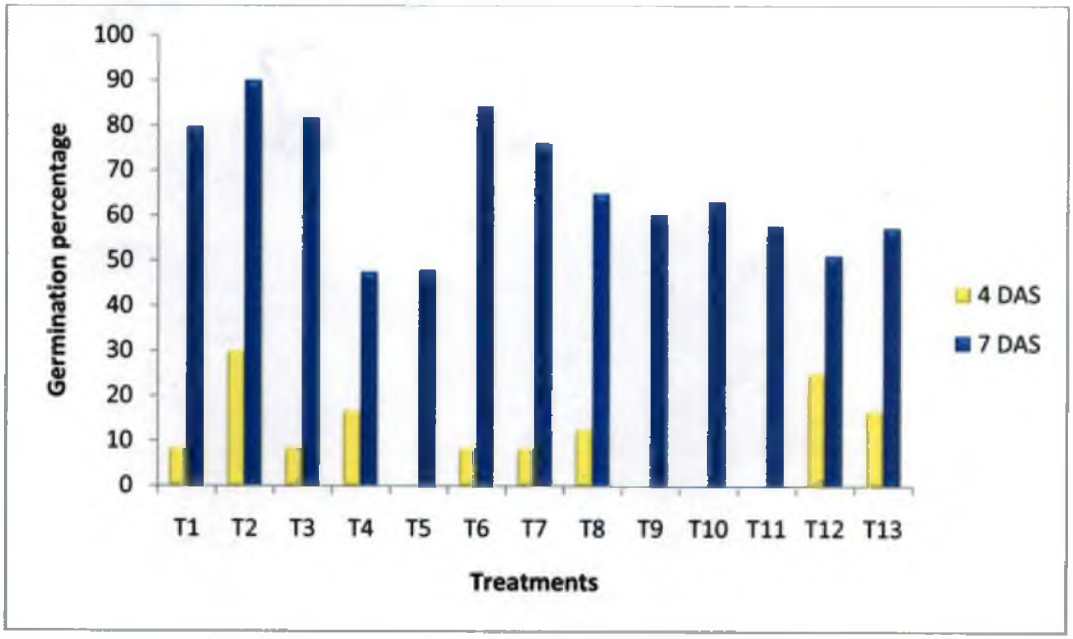
5.3.1 Germination percentage

The treatment receiving FYM alone (T_2) recorded the highest percentage of germination followed by T_6 (adhoc POP) as depicted in Fig.9. The results revealed that the seed treatment with Azospirillum, Phosphate Solubilising Bacteria, Pseudomonas and the application of FYM as basal dose has enhanced the germination percentage. The humic acid present in FYM might have involved in stimulation of growth substances resulting in early germination. (Velmurugan., 2005). Several microorganisms present in *beejamrutham* and FYM improved the seed germination, seedling length and vigour by enhancing the microbial population and biological activity in the soil (Sreenivasa *et al* ., 2007).

5.3.2 Length of vines

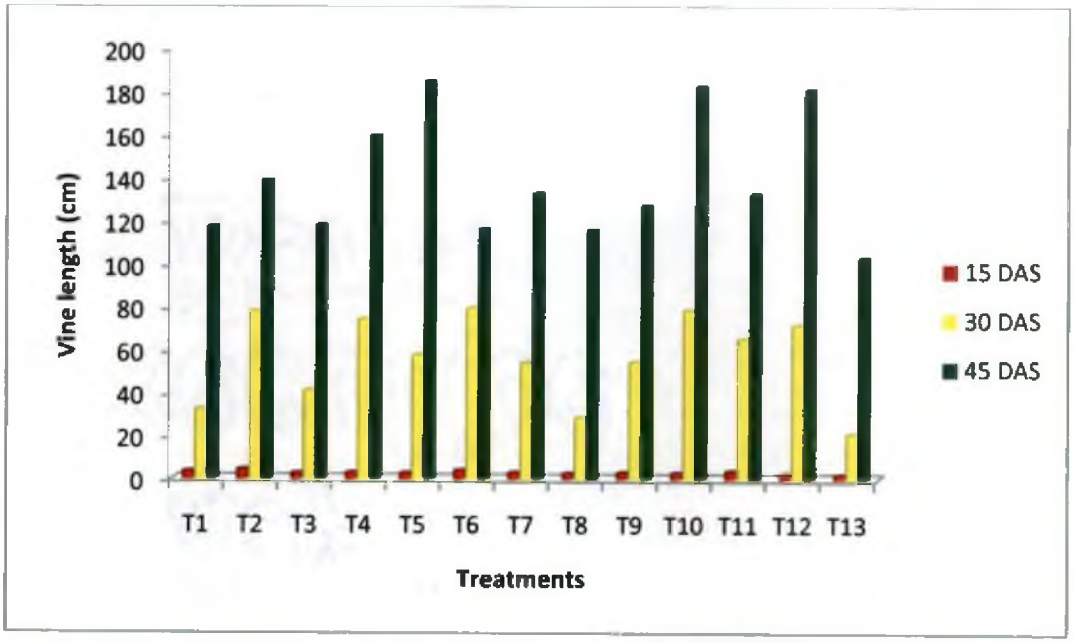
The treatment receiving FYM alone (T_2) recorded maximum vine length (4.48cm) on 15DAS (Fig.10) while T_6 (Adhoc POP) had the maximum of 79.52 cm on 30DAS. T_5 recorded maximum vine length on 45DAS (185.00cm). Application of organic manures registered significantly higher plant growth and was superior to other treatments. Raj (1999) obtained better response in okra due to the application of organic manures (oil cakes, green leaf, poultry manure, FYM and enriched compost) than the POP recommendation.

Fig.9. Percentage of germination as influenced by different treatments



T_1 - POP
T_2 - FYM alone
T_3 - N P K alone
T_4 - PM
T_5 - PM + N P K
T_6 - Adhoc POP
T_7 - PM + NC
T_8 - *Beejamrutham* + *Jeevamrutham* +Mulching
T_9 - T8 + PM
T_{10} - PM + *Beejamrutham* +*Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam*
T_{12} - PM + Fish amino acid
T_{13} - Control

Fig.10. Length of vine as influenced by different treatments



T_1 - POP
T_2 - FYM alone
T_3 - N P K alone
T_4 - PM
T_5 - PM + N P K
T_6 - Adhoc POP
T_7 - PM + NC
T_8 - *Beejamrutham* + *Jeevamrutham* +Mulching
T_9 - T8 + PM
T_{10} - PM + *Beejamrutham* +*Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam*
T_{12} - PM + Fish amino acid
T_{13} - Control

Plate 3. Plants in the treatment T_1 at different growth stages

4 days after sowing

15 days after sowing

25 days after sowing

Flowering stage

Harvested fruits

Plate 4. Plants in the treatment T_2 at different growth stages

7 days after sowing

15 days after sowing

20 days after sowing

25 days after sowing

Harvesting

5.3.3 Number of leaves

The treatment variation was significant in respect of number of leaves during the vegetative and reproductive stages. The effect of number of leaves at 15 days interval as influenced by different treatments is presented in Fig.11. The data showed that FYM and vermi compost performed consistently better among the various treatments, with respect to all the growth components.T_6 and T_{10} recorded the maximum number of leaves (5.32) on 15DAS. T_{10} recorded maximum number of leaves (25.67) on 30 DAS which was significantly superior to all other treatments.T_{12} recorded maximum number of leaves at 45 DAS followed by T_1 and T_{11}, which were on par with each other. The increase in plant growth might be because of the suitable soil rhizosphere and nutrient status,which facilitated earlier and better growth.

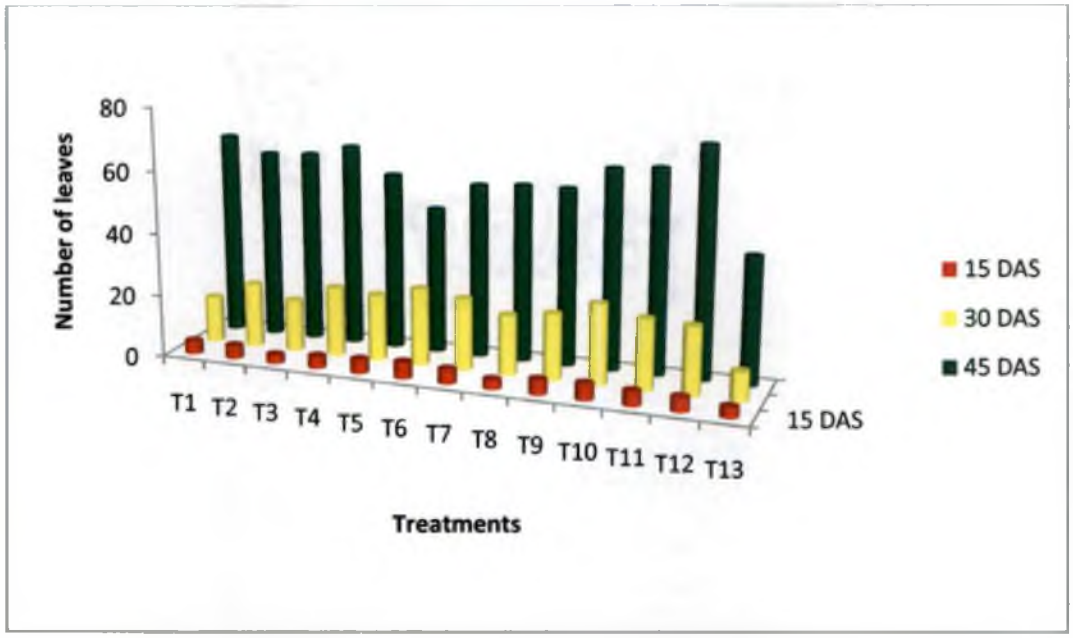
5.3.4 Number of branches per plant

On 30 DAS, the treatment receiving FYM + vermi compost and poultry manure + *Beejamrutham* + *Jeevamrutham* recorded the maximum number of branches plant^{-1} (2.67). On 45 DAS, T_{12} recorded maximum number of branches plant^{-1} (5.7) followed by T_{10} (5.6).The number of branches was more in the organic treatments than in the inorganic ones (Fig.12).

Significant influence on growth characters due to the enhancement of uptake of nutrients favoured by the addition of organic manures was reported by Cosenova *et al.*,(1990).

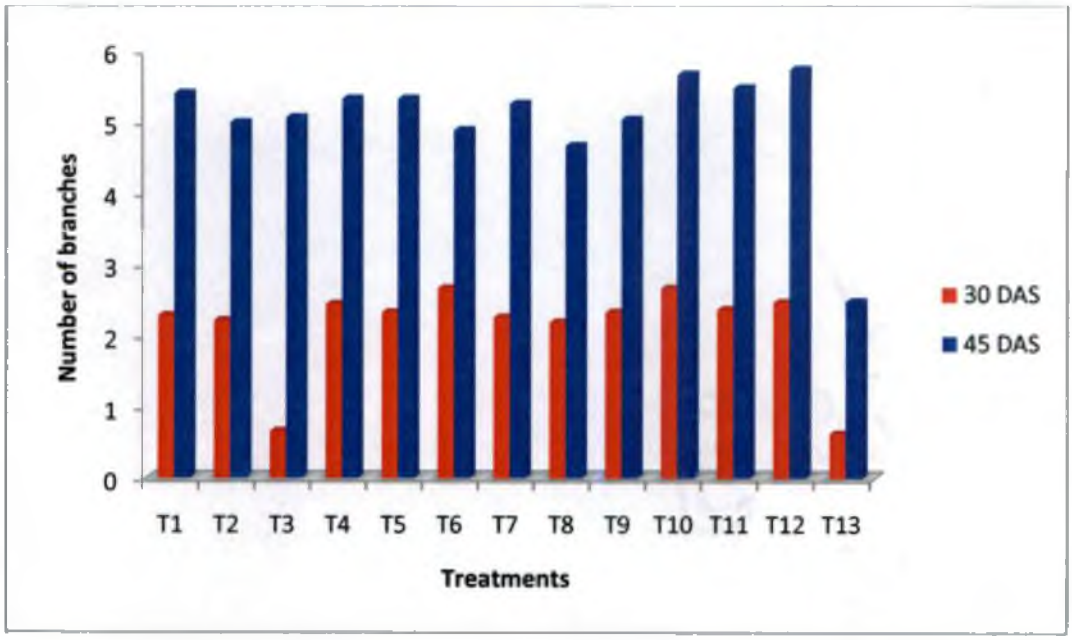
The beneficial effect of poultry manure in improving vegetative growth might be due to better availability of essential plant nutrients, rapid mineralization and favourable C:N ratio (Mali *et al* ., 2005.,Shelke et al., 2005 and Prabhakaran, 2003).

Fig.11. Number of leaves as influenced by different treatments



T_1 - POP
T_2 - FYM alone
T_3 - N P K alone
T_4 - PM
T_5 - PM + N P K
T_6 - Adhoc POP
T_7 - PM + NC
T_8 - *Beejamrutham* + *Jeevamrutham* +Mulching
T_9 - T8 + PM
T_{10} - PM + *Beejamrutham* +*Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam*
T_{12} - PM + Fish amino acid
T_{13} - Control

Fig.12. Number of branches as influenced by different treatments



T_1 - POP
T_2 - FYM alone
T_3 - N P K alone
T_4 - PM
T_5 - PM + N P K
T_6 - Adhoc POP
T_7 - PM + NC
T_8 - *Beejamrutham* + *Jeevamrutham* +Mulching
T_9 - T8 + PM
T_{10} - PM + *Beejamrutham* +*Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam*
T_{12} - PM + Fish amino acid
T_{13} - Control

Plate 5. Plants in the treatment T_3 at different growth stages

7 days after sowing

15 days after sowing

15 days after sowing

Flowering stage

Taking observation

Harvested fruits

Plate 6. Plants in the treatment T_4 at different growth stages

7 days after sowing

15 days after sowing

15 days after sowing

Flowering stage

Harvesting

5.3.5 Dry matter production

Among the treatments, T_6 (Adhoc POP) registered the highest dry matter yield of 52.33g plant^{-1} on 30 DAS. The DMP on 60 DAS was the maximum for T_9 (113.33g plant^{-1}).The same trend was noticed in the harvest also (Fig.13). Improved performance was observed with respect to DMP when poultry manure + fish amino acid application was resorted to. This might be due to faster decomposition of organic manures, thereby increasing the availability of nutrients, especially nitrogen, which helps in protein synthesis and ultimately resulting in more DMP (Subbiah *et al.*,1983).

The increased DMP was the result of better plant growth as reflected by increased plant height, more branches and higher number of leaves. Production of photosynthates and its effective utilization might be another reason for the increased biomass. Similar results were obtained by Babalad (2005), Dhananjaya (2007), and Shijini (2010).

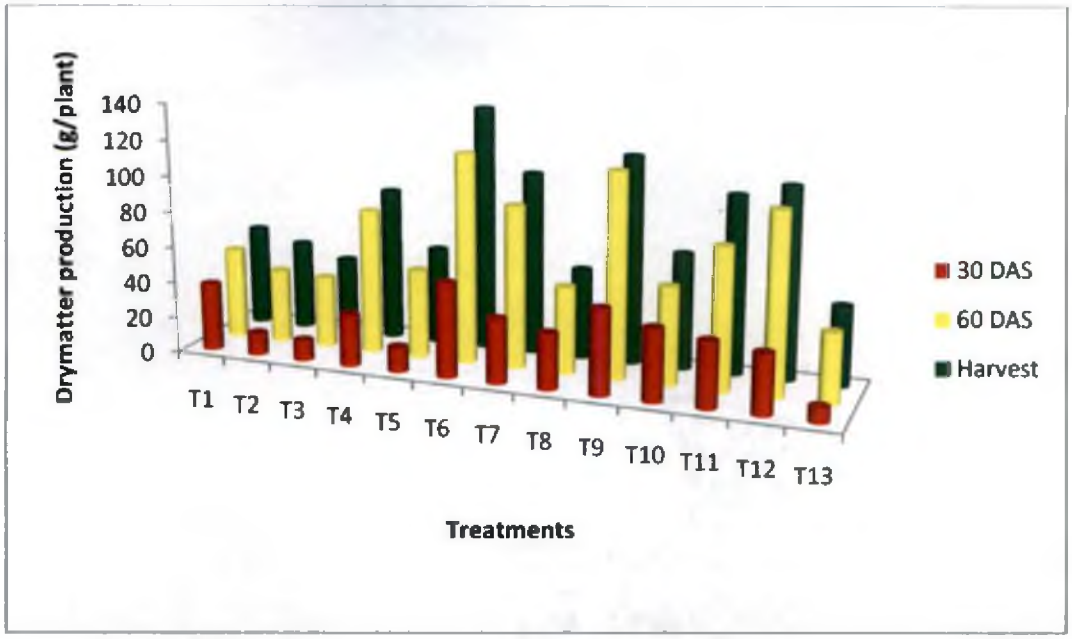
5.4 PHYSIOLOGICAL CHARACTERS

5.4.1 Chlorophyll content

The highest content of chlorophyll was observed in the treatment receiving adhoc POP (T_6) which is depicted in Fig.14. Application of organic inputs especially foliar spray of liquid organic manures showed accumulation of nutrients in leaf tissues, which in turn ensured better photosynthetic efficiency causing greater synthesis, translocation and accumulation of carbohydrates and chlorophyll (Gathala *et al.*, 2007).

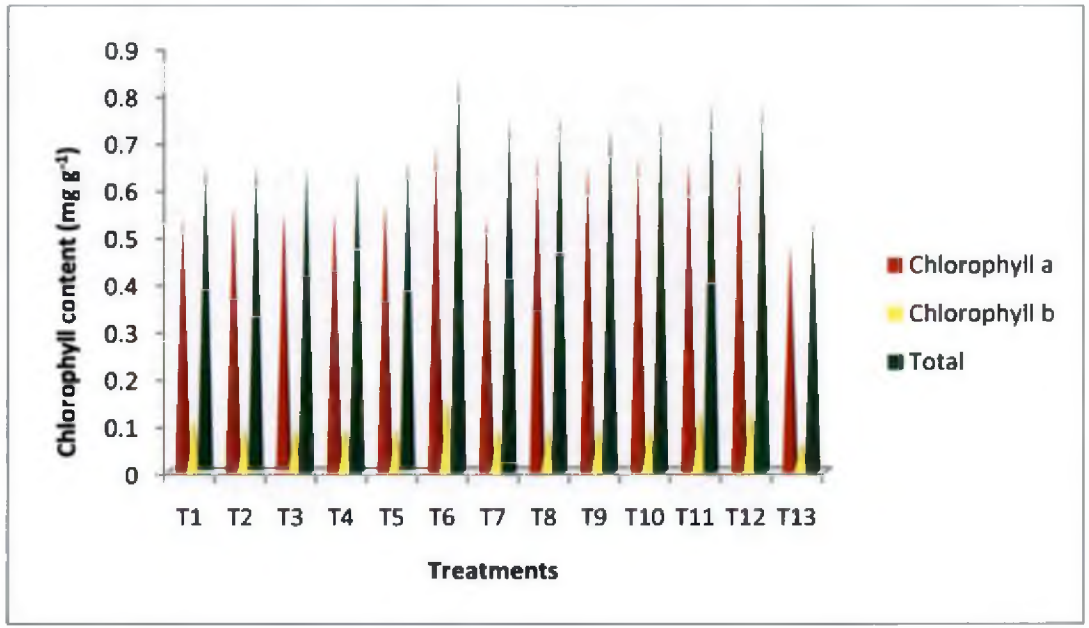
The presence of Azospirillum and kinetin along with other enzymes in panchagavyam might have increased the chlorophyll content of leaves since they play a vital role in N fixation and pigment synthesis (Sanjutha *et al* ., 2005 and Sridhar *et al.*, 2001).

Fig.13. Dry matter production as influenced by different treatments



T_1 - POP
T_2 - FYM alone
T_3 - N P K alone
T_4 - PM
T_5 - PM + N P K
T_6 - Adhoc POP
T_7 - PM + NC
T_8 - *Beejamrutham* + *Jeevamrutham* +Mulching
T_9 - T8 + PM
T_{10} - PM + *Beejamrutham* +*Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam*
T_{12} - PM + Fish amino acid
T_{13} - Control

Fig.14. Chlorophyll content as influenced by different treatments



T_1 - POP
T_2 - FYM alone
T_3 - N P K alone
T_4 - PM
T_5 - PM + N P K
T_6 - Adhoc POP
T_7 - PM + NC
T_8 - *Beejamrutham* + *Jeevamrutham* +Mulching
T_9 - T8 + PM
T_{10} - PM + *Beejamrutham* +*Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam*
T_{12} - PM + Fish amino acid
T_{13} - Control

Plate 7. Plants in the treatment T_5 at different growth stages

Manuring

20 days after sowing

Flowering stage

Fruiting stage

Harvesting

5.4.2 Leaf area index

The treatment receiving poultry manure and *panchagavyam* recorded highest LAI on 15 DAS, 30 DAS and 45 DAS (3.9, 4 and 4.3, respectively as indicated in Fig.15. The prominent form of nitrogen in poultry manure is uric acid that readily transforms to ammoniacal form which is easily available for plants and this resulted in increased LAI because of effective utilization of sunlight and nutrients (Babu, 2004., Nadabuaku and Kassim, 2003 and Singh, 2009). The maximum leaf area in panchagavyam treated plants might be due to the leaf expansion facilitated by the growth regulators which favoured cell elongation and better N assimilation as reported by Natarajan, 2003 and Somasundaram *et al.*, 2003.

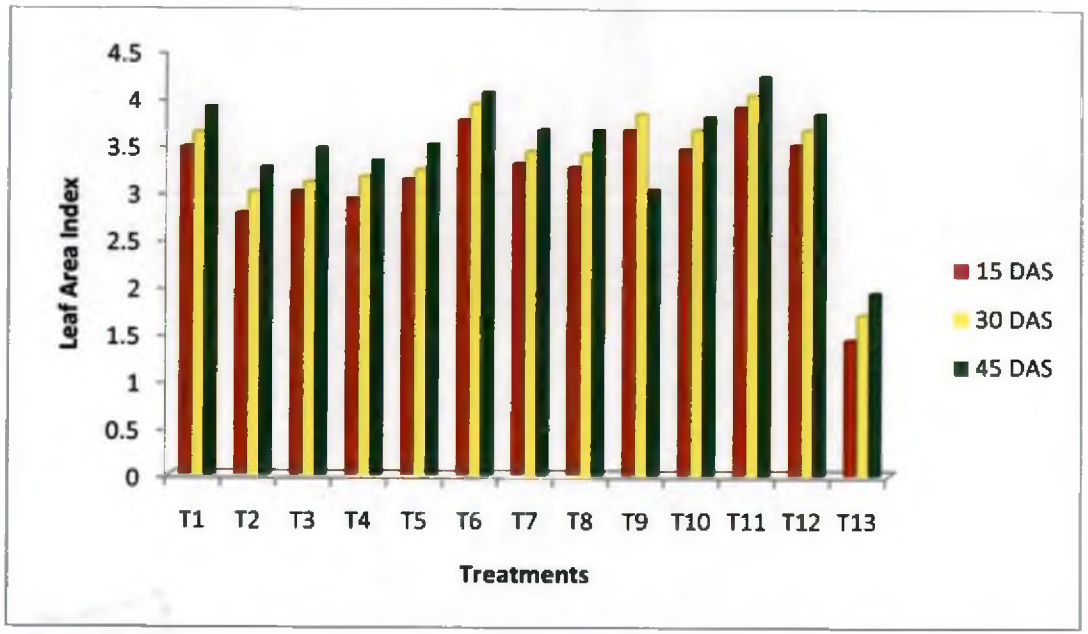
5.5 YIELD AND YIELD ATTRIBUTES

5.5.1 Yield

The maximum total fruit yield was recorded in treatments receiving adhoc POP (T_6). Highest yield of 53.94 t ha^{-1} was recorded in T_6 which was 5.5 t ha^{-1} more than the present POP recommendations (Fig.16). Consistently improved growth of plants resulted in the prolonged and enhanced production of fruits in these treatments. In cucumber, yield attributes mainly include earliness in flowering and harvest, prolonged crop duration and fruit yield per plant. Positive influence of the organic treatments could be reflected in improved vegetative growth which significantly influenced the yield potential of cucumber. All the vegetative and reproductive parameters were positively influenced by organic manure application.

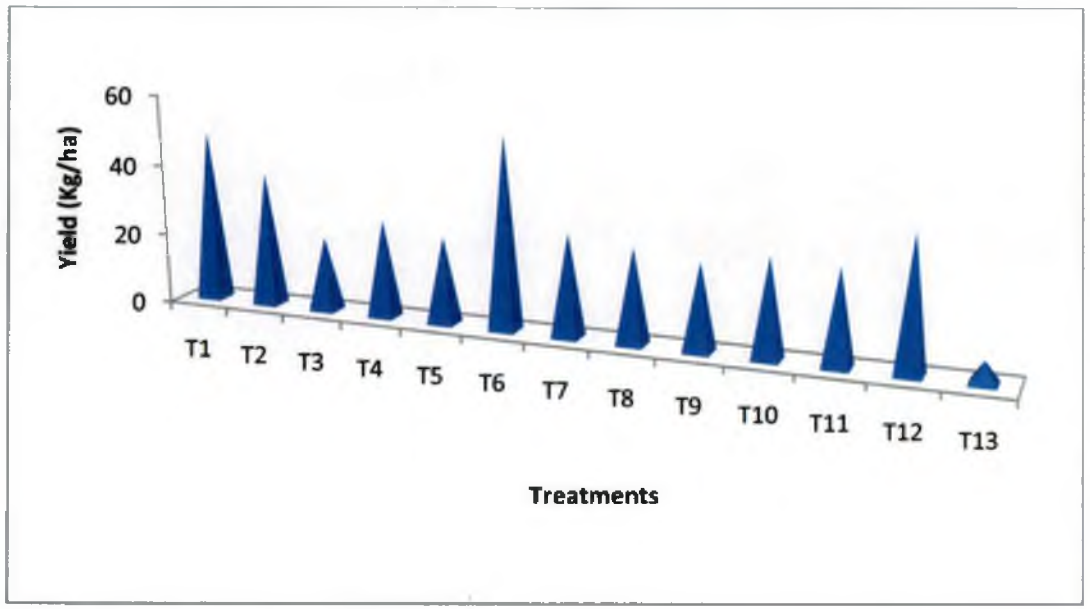
The beneficial effect on yield might be due to better plant growth by the sustained and increased availability of nutrients throughout the growth phase and enhanced photosynthesis and accelerated mobility of photosynthates from the source to sink as influenced by the growth hormones released or synthesized from these manures (Natarajan, 2003). Application of vermi compost along with organic manures resulted in early flowering, increased fruit size, number of fruits and yield in tomato and chilli (Prabhu *et al.*, 2010).

Fig.15. Leaf area index as influenced by different treatments



T_1 - POP
T_2 - FYM alone
T_3 - N P K alone
T_4 - PM
T_5 - PM + N P K
T_6 - Adhoc POP
T_7 - PM + NC
T_8 - *Beejamrutham* + *Jeevamrutham* +Mulching
T_9 - T8 + PM
T_{10} - PM + *Beejamrutham* +*Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam*
T_{12} - PM + Fish amino acid
T_{13} - Control

Fig.16. Yield as influenced by different treatments



T_1 - POP
T_2 - FYM alone
T_3 - N P K alone
T_4 - PM
T_5 - PM + N P K
T_6 - Adhoc POP
T_7 - PM + NC
T_8 - *Beejamrutham* + *Jeevamrutham* +Mulching
T_9 - T8 + PM
T_{10} - PM + *Beejamrutham* +*Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam*
T_{12} - PM + Fish amino acid
T_{13} - Control

Plate 8. Plants in the treatment T_6 at different growth stages

15 days after sowing

15 days after sowing

15 days after sowing

20 days after sowing

30 days after sowing

Harvesting

Plate 9. Plants in the treatment T_7 at different growth stages

Sowing

10 days after sowing

25 days after sowing

Harvesting

5.5.2 Days to first flower opening and harvest

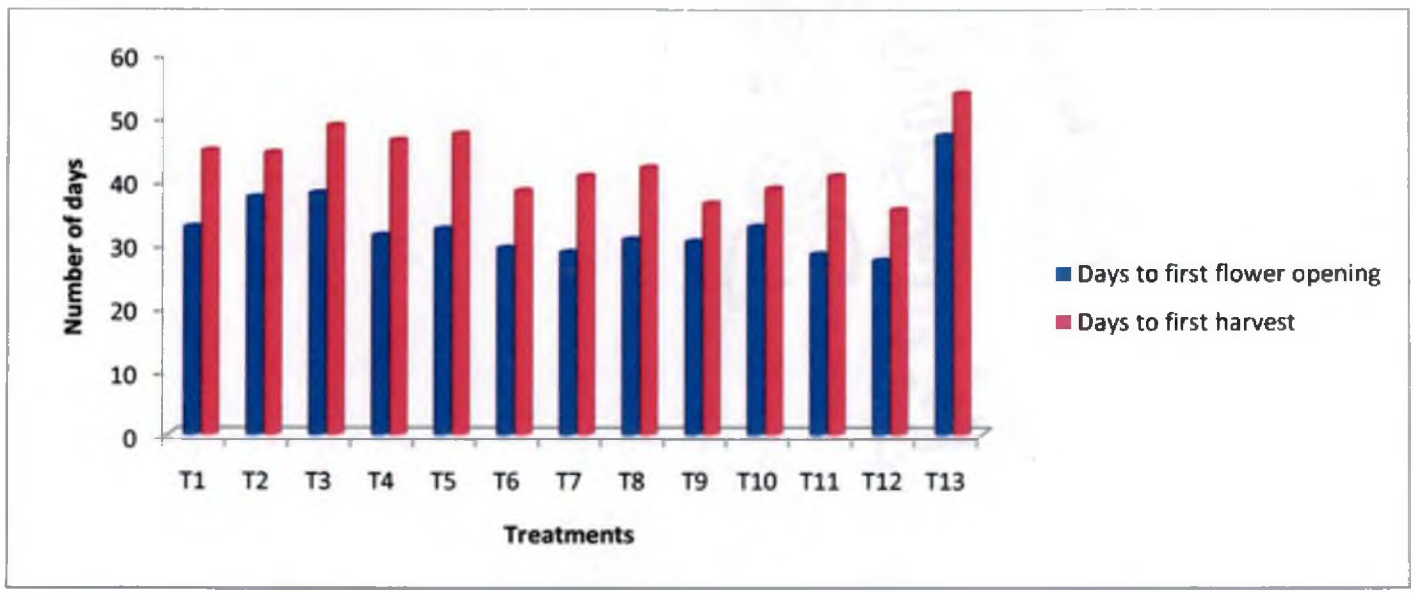
The plants should be either early in flowering or should be under prolonged reproductive phase to get more number of harvests. The first female flower appeared in the treatment receiving poultry manure + fish amino acid on 27 DAS whereas it took 47 days in the control plots (Fig.17).

Earliness in flowering by 5 days due to application of combinations of FYM and panchagavyam was reported by Kumaran *et al.*, (1998) in tomato. Similarly Rekha (1999) and Krishna (2005) found early flowering by the application of poultry manure in brinjal and cowpea. Shijini (2010) reported that early flowering in papaya could be attributed to higher availability and uptake of nutrients from poultry manure.

Panchagavya, when sprayed on foliage facilitates instant uptake of nutrients (Sharma,1970) which leads to the effective conversion of vegetative phase to flowering phase. Further, the enhanced vegetative growth coupled with adequate reserved food materials promotes easy differentiation of vegetative buds into flower buds leading to earliness in flowering and increase in the number of flowering shoots. Similarly, the reproductive growth was also positively affected by panchagavyam , resulting in earliness of flowering due to the cell differentiation and flower bud formation activity of the cytokinin present in panchagavyam .

The treatment receiving PM + FAA (T_{12}) showed early harvesting. The first harvest was taken from T_{12} on 35DAS. The treatment receiving T_{13} (control) recorded the highest number of days (54) for first harvest (Fig.17).

Fig.17. Days to first flower opening and first harvest as influenced by different treatments



T_1 - POP
T_2 - FYM alone
T_3 - N P K alone
T_4 - PM
T_5 - PM + N P K
T_6 - Adhoc POP
T_7 - PM + NC
T_8 - *Beejamrutham* + *Jeevamrutham* +Mulching
T_9 - T8 + PM
T_{10} - PM + *Beejamrutham* +*Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam*
T_{12} - PM + Fish amino acid
T_{13} - Control

Plate 10. Plants in the treatment T_8 at different growth stages

3 days after sowing

Mulched plants

25 days after planting

Flowering stage

Harvesting

5.5.3 Number and weight of fruits plant

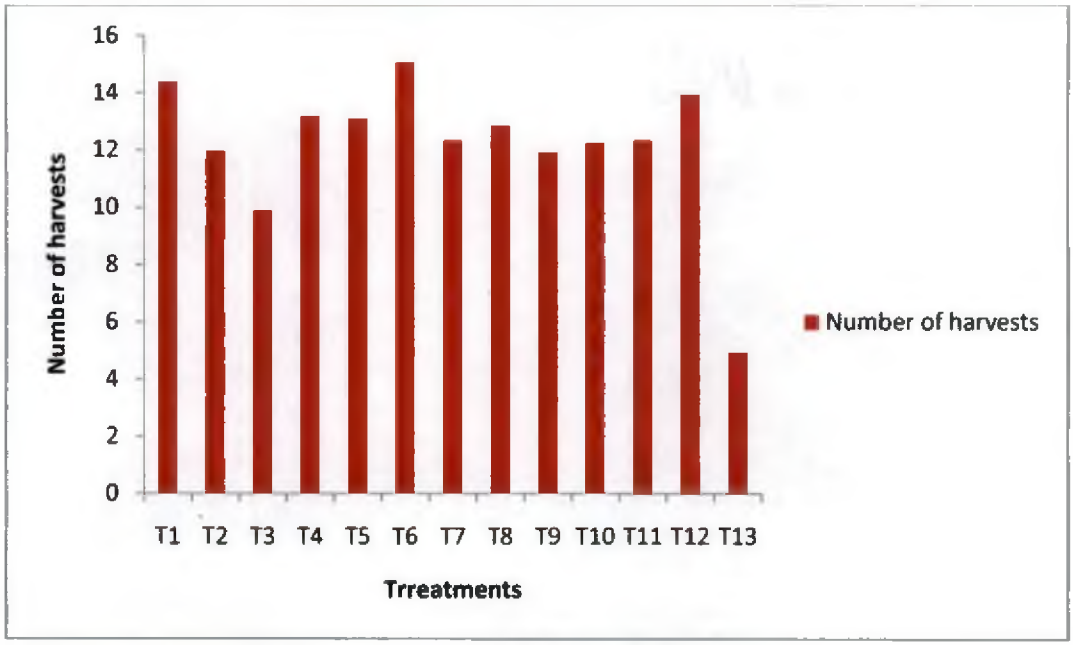
Yield of economic part is the most important parameter which decides the profitability of a crop. The maximum number of fruits per plant was registered in T_6 (23) which was significantly higher than all other treatments (Fig.18). It could be seen that FYM and vermi compost application increased the number of female flowers leading to more number of fruits. The lowest fruit number was recorded in T_{13} (7). The enhancing effect of panchagavyam in vegetative phase accompanied with highest number of flowers in reproductive phase might have positively attributed to the highest number of fruits.

The treatments differed significantly for weight of fruits. Vermicompost + FYM recorded the maximum weight of fruits (16.597 kg plant^{-1}) which was significantly superior to other treatments.T_{13} recorded lowest weight of 1.87 kg plant^{-1} (Fig.19).

5.5.4 Number of seeds per fruit

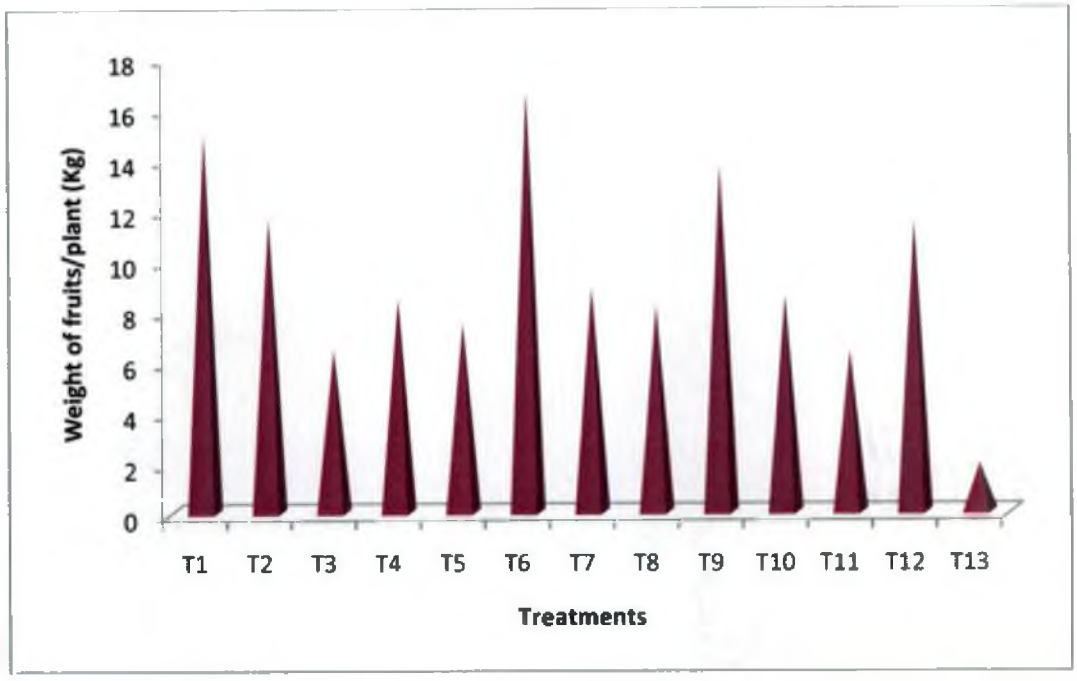
The number of seeds per fruit was found to be influenced by various treatments (Fig. 20). The highest number of seeds per fruit was recorded in the treatment T_6 (676), which was significantly superior to all other treatments. T_{13} recorded minimum no of seeds fruit^{-1}(203). The improvement in seed yield could be attributed to balanced C:N ratio, organic matter build up, better root proliferation, enhanced nutrient availability, accelerated transport and higher concentration of plant nutrients (Chattoo *et al.*, 2009). These might have lead to better photosynthesis and efficient translocation of photosynthates from the source to sink, resulting in an improvement in fruit yield and related attributes.

Fig.18. Number of harvests as influenced by different treatments



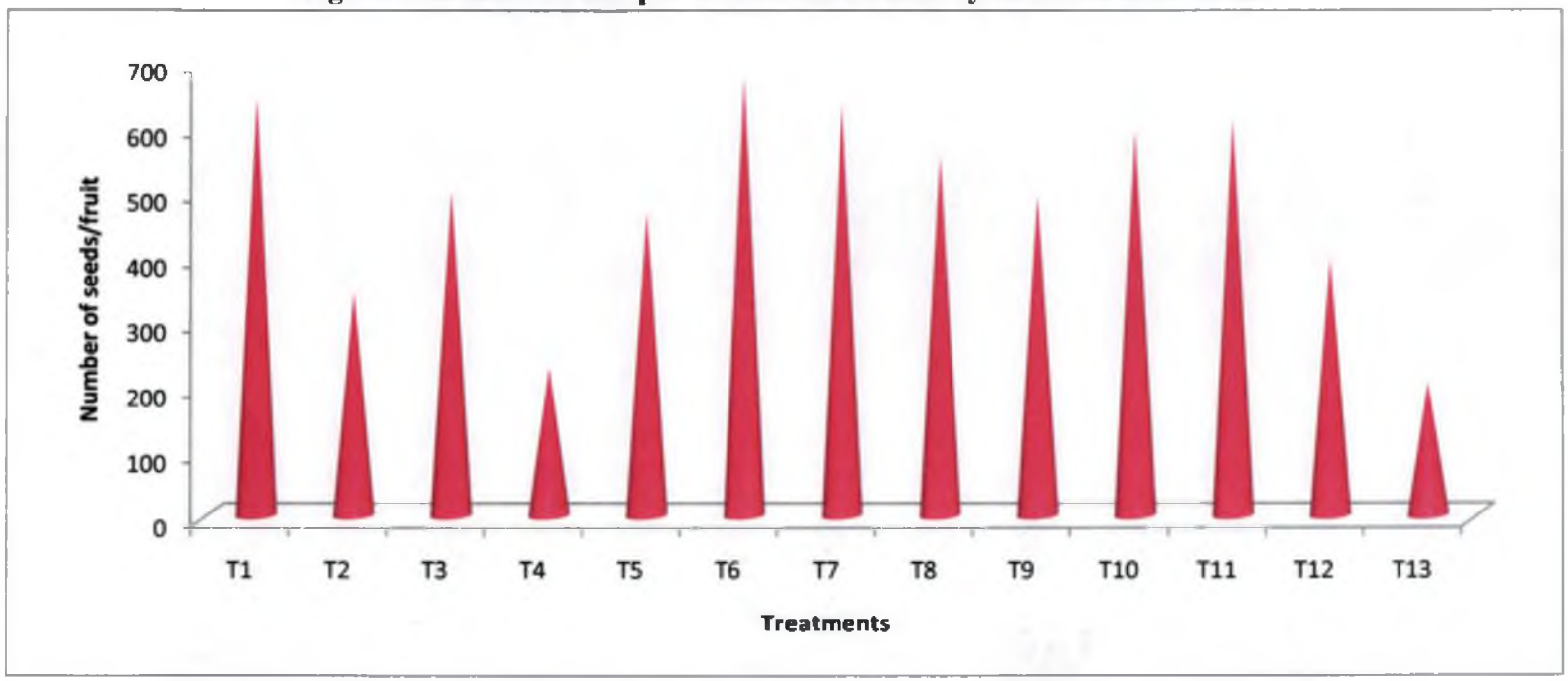
T_1 - POP
T_2 - FYM alone
T_3 - N P K alone
T_4 - PM
T_5 - PM + N P K
T_6 - Adhoc POP
T_7 - PM + NC
T_8 - *Beejamrutham* + *Jeevamrutham* +Mulching
T_9 - T8 + PM
T_{10} - PM + *Beejamrutham* +*Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam*
T_{12} - PM + Fish amino acid
T_{13} - Control

Fig.19. Weight of fruits per plant as influenced by different treatments



T_1 - POP
T_2 - FYM alone
T_3 - N P K alone
T_4 - PM
T_5 - PM + N P K
T_6 - Adhoc POP
T_7 - PM + NC
T_8 - *Beejamrutham* + *Jeevamrutham* +Mulching
T_9 - T8 + PM
T_{10} - PM + *Beejamrutham* +*Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam*
T_{12} - PM + Fish amino acid
T_{13} - Control

Fig.20. Number of seeds per fruit as influenced by different treatments



T_1 - POP
T_2 - FYM alone
T_3 - N P K alone
T_4 - PM
T_5 - PM + N P K
T_6 - Adhoc POP
T_7 - PM + NC
T_8 - *Beejamrutham* + *Jeevamrutham* +Mulching
T_9 - T8 + PM
T_{10} - PM + *Beejamrutham* +*Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam*
T_{12} - PM + Fish amino acid
T_{13} - Control

Plate 11. Plants in the treatment T_9 at different growth stages

3 days after sowing

15 days after sowing

Mulching

25 days after sowing

Harvesting

Plate 12. Plants in the treatment T_{10} at different growth stages

5 days after sowing

Mulching

15 days after sowing

25 days after sowing

Harvesting

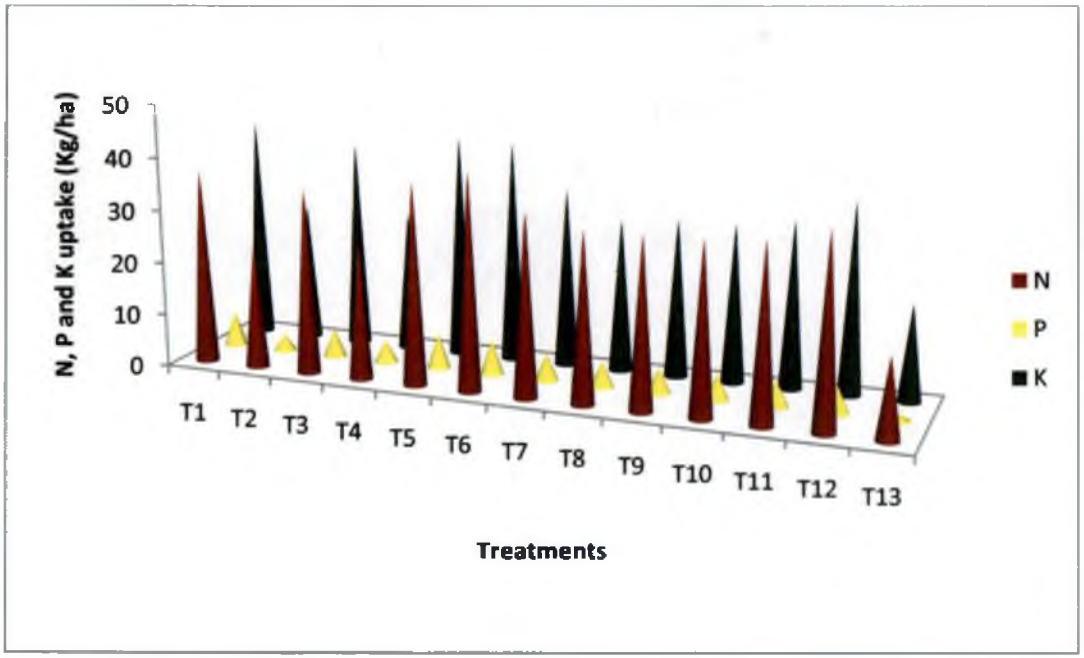
5.5.5 Nutrient Uptake

The highest N content of leaves in treatments containing poultry manure might be due to release of nitrogen from poultry manure as uric acid, which is readily available to plants and possess 60% nitrogen in the ammoniacal form, helps in the efficient utilization by the plants (Mali *et al.*, 2005 and Shelke *et al.*, 2005). More nitrogen content in leaves under treatment with poultry manure in the present study can also be counted as a reason for positive influence of this organic source on the yield attributes of cucumber.

Monitoring the treatment variation on the concentration and uptake of major nutrients indicated significant effect during harvest. FYM, vermi compost and poultry manure maintained enhanced concentration of NPK throughout the growth period, comparable to that of inorganic nutrition and POP. Estimation of NPK during the last stage of crop growth clearly indicated that application FYM, vermi compost and cowdung slurry resulted in increased N content. The treatment receiving T_6 had highest N uptake (40.807 kg ha^{-1}).The treatment receiving T_5 (poultry manure + NPK) had highest P_2O_5 (6.543 kg ha^{-1}) and K_2O (42.55 kg ha^{-1}) as depicted in Fig. 21. This is probably due to the build up of major nutrients in soil in plots treated with FYM, vermi compost and poultry manure.

The improvement in soil conditions might have enhanced the ability of cucumber plant to draw more nutrients from larger area and greater depth. Thus the uptake pattern corrobate the cucumber yield as observed by Mali *et al.*(2005) and Prabhakaran (2003). The application of liquid organics such as cow dung slurry, resulted in higher uptake of N, P and K by tomato plants (1.25 to 1.26 g plant $^{-1}$, 0.07 to 0.08 g plant $^{-1}$ and 0.84 to 0.86 g plant $^{-1}$, respectively) than those which received the RDF (Magray *et al.*,2011).

Fig.21. N, P and K uptake as influenced by different treatments



T_1 - POP
T_2 - FYM alone
T_3 - N P K alone
T_4 - PM
T_5 - PM + N P K
T_6 - Adhoc POP
T_7 - PM + NC
T_8 - *Beejamrutham* + *Jeevamrutham* +Mulching
T_9 - T8 + PM
T_{10} - PM + *Beejamrutham* +*Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam*
T_{12} - PM + Fish amino acid
T_{13} - Control

Plate 13. Plants in the treatment T_{11} at different growth stages

25 days after sowing

25 days after sowing

Harvesting

Harvesting

Plate 14. Plants in the treatment T_{12} at different growth stages

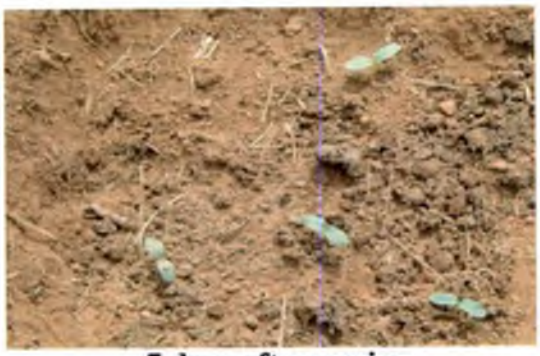
10 days after sowing

15 days after sowing

35 days after sowing

Harvesting

Plate 15. Plants in the treatment T_{13} at different growth stages



7 days after sowing

20 days after harvesting

25 days after sowing

Fruiting stage

5.6 QUALITY ATTRIBUTES

Balanced nutrient supply is necessary not only for obtaining higher and regular yield of better quality fruits but also for increasing the shelf life of fruits. Increase in shelf life and minimum post harvest loss will go a long way in increased fruit availability.

The treatment receiving poultry manure + fish amino acid recorded the maximum shelf life of 9 days followed by T_{11} (7).The treatment receiving fertilizer alone (T_3) has recorded the minimum shelf life of 4 days. The control plot recorded slightly higher shelf life (Fig.22 and Fig.23).

Higher shelf life might be attributed to the phenomenon that altered physiological and biological constituents of fruit as influenced by organic manures and that might have led to the reduced respiration which in turn resulted in higher storage life. This confirm the findings of Linder (1985) and Shijini (2010).

Respiration rate and enzyme activity will be lower in organically produced fruits which help in reduced storage lossess. Similar findings were also observed by Patil *et al.* (2009) where better shelf life, superior taste and better shining of fruits increased the marketability of the produce. Brinjal was grown organically using pot culture by Patil *et al.*(2009) where the soil was amended organically using oxygenated peptone for soil conditioning. He also reported the improvement in enzyme activity of catalase peroxidase and polyphenol oxidase. Better shelf life, superior taste and better shining of fruits increased its marketability.

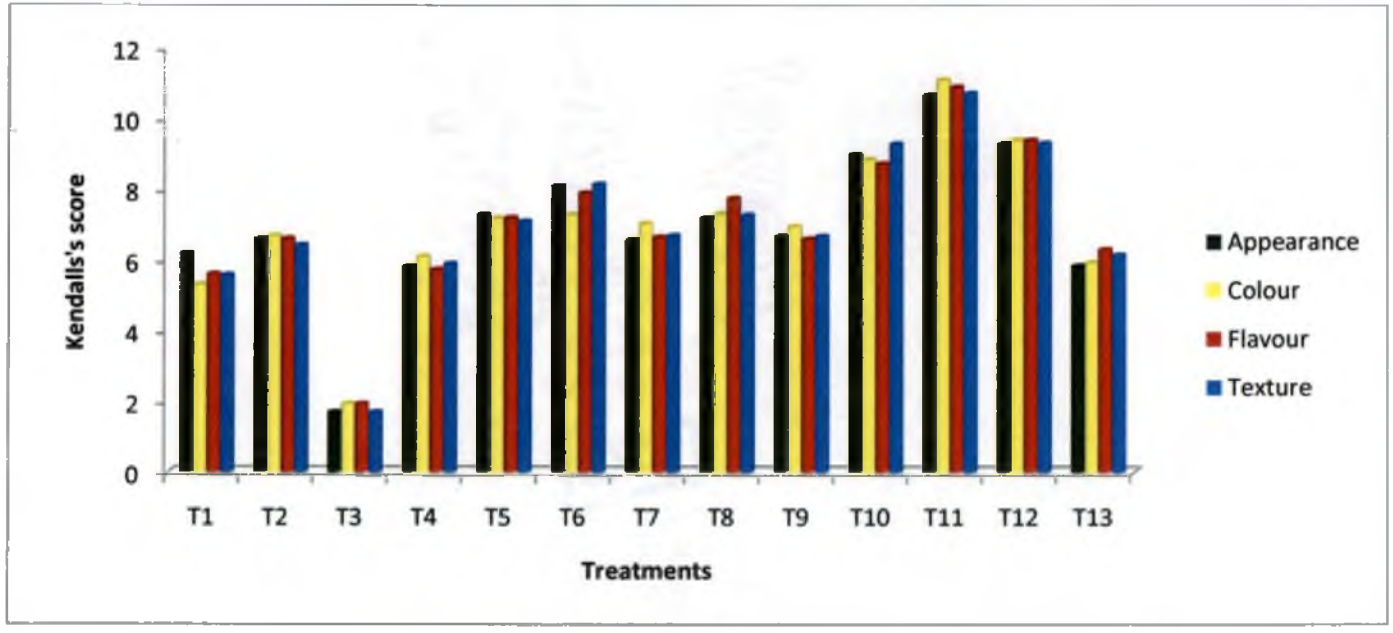
When an acceptability test was conducted, the panelist preferred organically grown cucumber to the chemically grown variant when they assessed the colour, taste, texture, flavour. The highest score for all characters in organoleptic test was observed in the treatment receiving panchagavyam and fish amino acid as foliar spray with basal application of poultry manure. The same trend was observed by Meirproger *et al.*(1989). Joseph (1998) also noticed the favourable influence of poultry manure in increasing the shelf life. Meirproger *et al.*(1989) could obtain superior results for organoleptic quality, storage quality, content of vitamin C and sugars when compost was applied to crops like tomato, beet root and cabbage. Importance of minerals like boron in keeping quality of fruits and tubers was indicated by Tisdale (1995) and he

found that the application of poultry manure favourably influenced the shelf life of the fruits.

5.7 INCIDENCE OF PESTS AND DISEASES

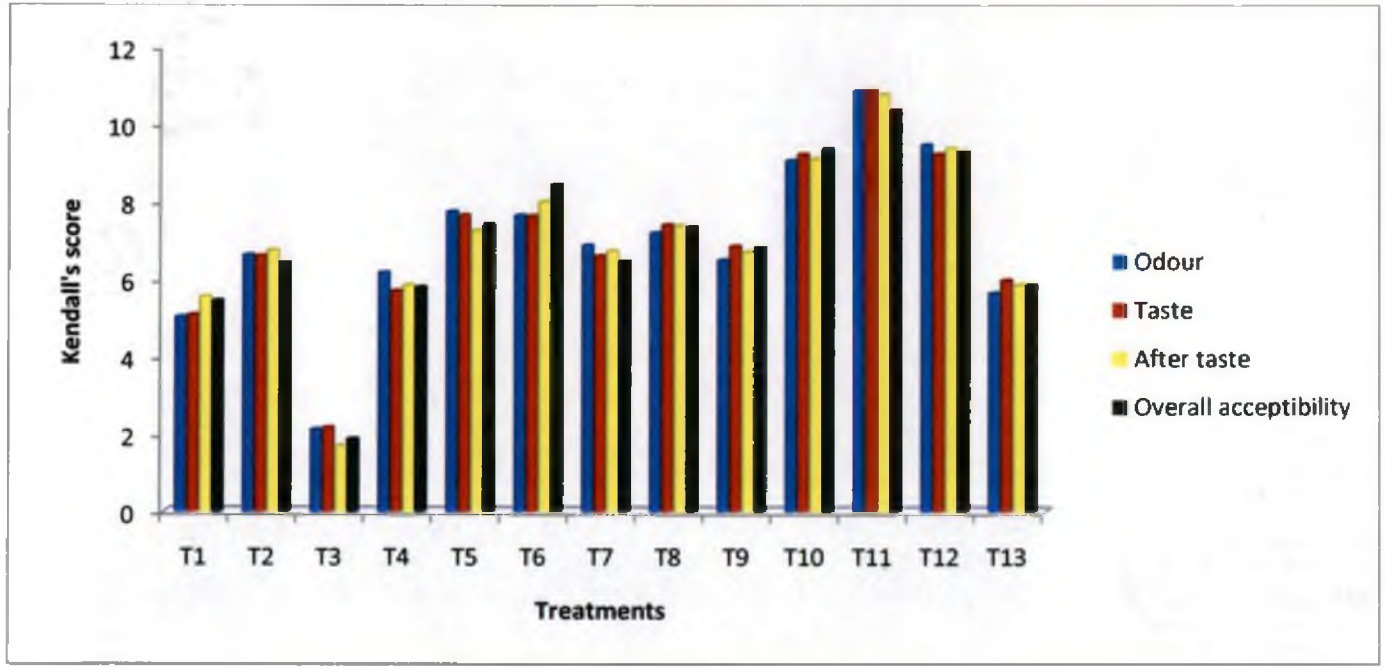
The incidence of pests was more in the treatments receiving fertilizers alone or in INM. The increasing levels of N in the form of inorganic fertilizers might have increased the vulnerability of the crop to the attack of fruit fly and pumpkin beetle. No incidence of diseases was noticed during the crop growth. The organic manures viz. FYM, poultry manure, vermi compost and neem cake along with liquid organic manures might have helped to prevent the pest attack. Lesser incidence of pests and diseases with the application of panchagavyam and neem cake was also reported by Solaiappan (2002), Sangeetha and Thevanathan (2010). The secondary metabolites produced by the beneficial micro organisms in panchagavyam might have helped to prevent the attack of pests and diseases. Complete suppression of mycelial growth of *Sclerotiana sclerotiorum* in cucumber was possible by the addition of different herbal plant extracts with fresh cow urine and cowdung as observed by Basak *et al.*, 2002 and Prasanna, 1998.

Fig.22. Quality attributes (appearance, colour, flavor and texture) of the fruit as influenced by different treatments



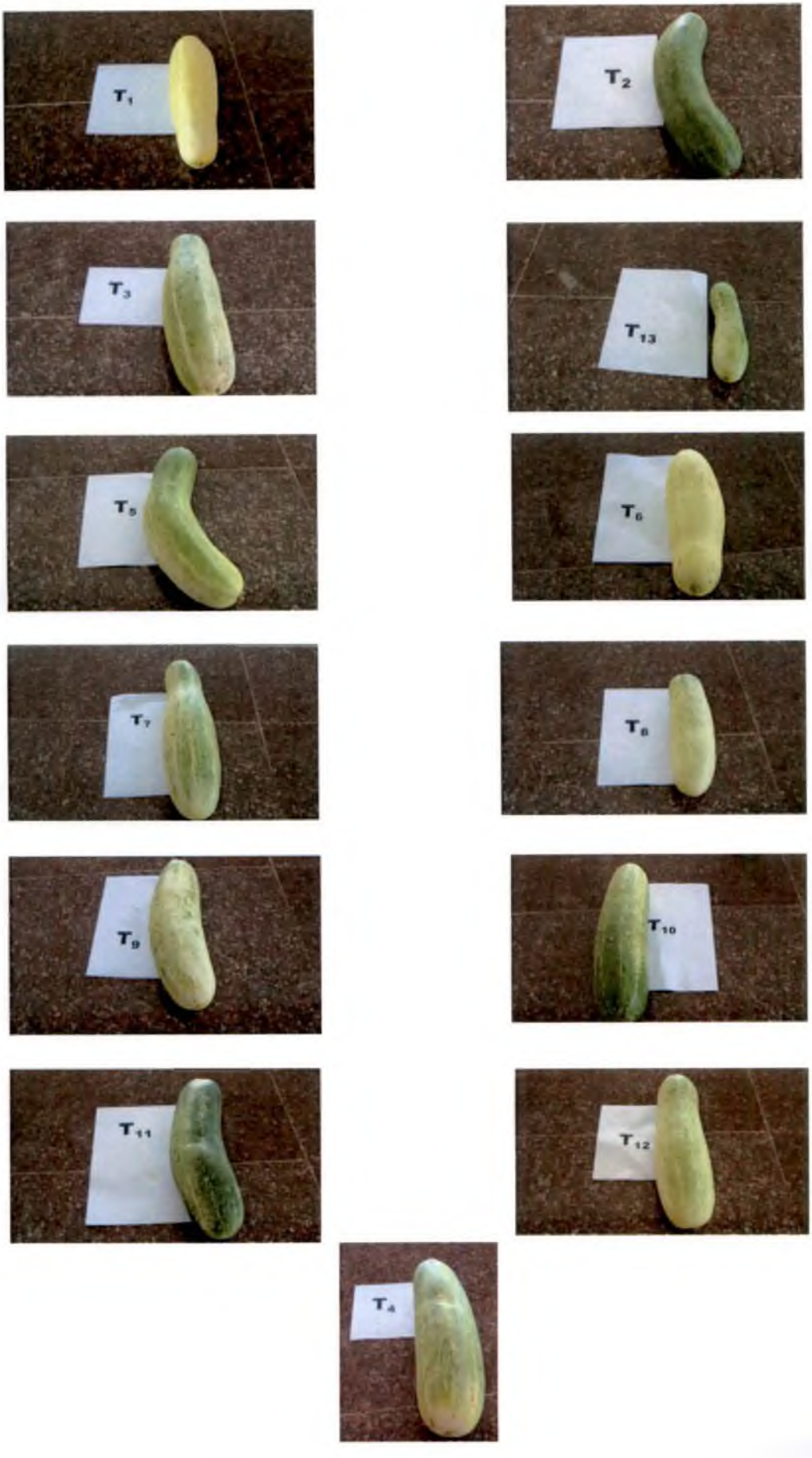
T_1 - POP
T_2 - FYM alone
T_3 - N P K alone
T_4 - PM
T_5 - PM + N P K
T_6 - Adhoc POP
T_7 - PM + NC
T_8 - *Beejamrutham* + *Jeevamrutham* +Mulching
T_9 - T8 + PM
T_{10} - PM + *Beejamrutham* +*Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam*
T_{12} - PM + Fish amino acid
T_{13} - Control

Fig.23. Quality attributes (odour, taste after taste and overall acceptibility,) of the fruit as influenced by different treatments



T_1 - POP
T_2 - FYM alone
T_3 - N P K alone
T_4 - PM
T_5 - PM + N P K
T_6 - Adhoc POP
T_7 - PM + NC
T_8 - *Beejamrutham* + *Jeevamrutham* +Mulching
T_9 - T8 + PM
T_{10} - PM + *Beejamrutham* +*Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam*
T_{12} - PM + Fish amino acidT_{13} - Control

Plate 16. Fruits from different treatments

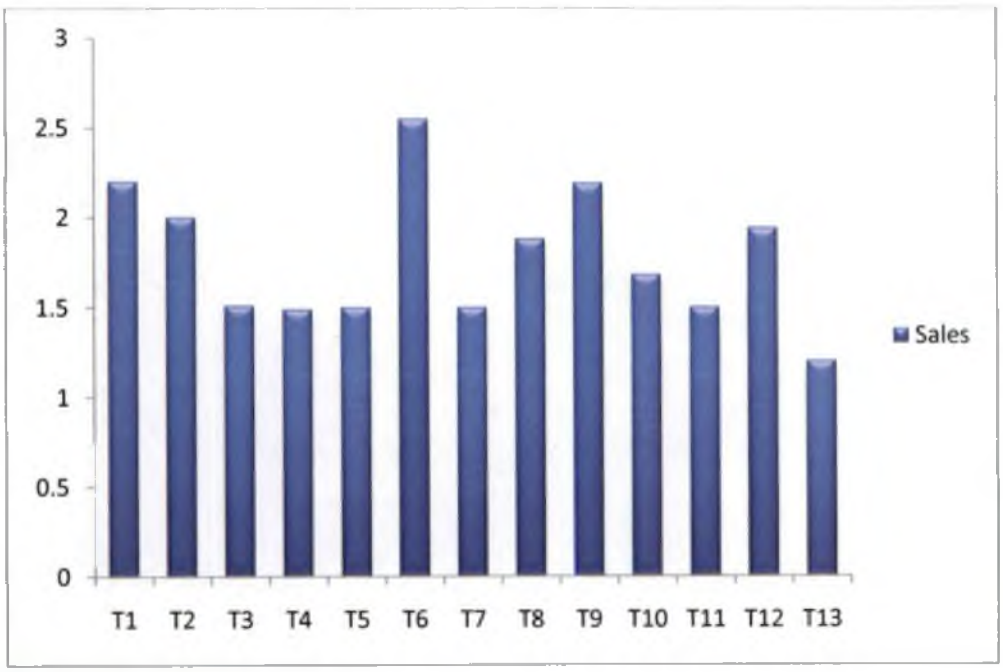


5.8 ECONOMIC ANALYSIS

The data on economic analysis furnished in Fig.24 reveal the significant difference in B:C ratio among the treatments. The Adhoc POP (FYM + Verm icompost + Cow dung slurry) could secure the highest B:C ratio of 2.5 which was 13% higher than the present package of practices recommendation. It could be achieved through several beneficial effects like increase in yield and selling at a slightly increased price of Rs.15/- per kg than the market price. If we could sell at premium price the profit will be increased. The treatment receiving control had the lowest B:C ratio of 1.2.

The economics of organic farming cannot be worked out merely based on yield per se. It encompasses the entire process and effects of organic farming in terms of benefits to human society including social costs, opportunity costs, unintended consequences, information asymmetrics and economics of sale.

Fig.24. B:C ratio as influenced by different treatments



T_1 - POP
T_2 - FYM alone
T_3 - N P K alone
T_4 - PM
T_5 - PM + N P K
T_6 - Adhoc POP
T_7 - PM + NC
T_8 - *Beejamrutham* + *Jeevamrutham* +Mulching
T_9 - T8 + PM
T_{10} - PM + *Beejamrutham* +*Jeevamrutham* + Without mulching
T_{11} - PM + *Panchagavyam*
T_{12} - PM + Fish amino acid
T_{13} - Controll

CONCLUSION

The study on "Nutrient management in organic farming of Cucumber (*Cucumis sativus* L.)" revealed the possibility of producing salad cucumber under organic management in a profitable manner. Application of FYM, vermi compost and cow dung slurry has contributed higher yield and foliar spraying of panchagavyam and fish amino acid contributed better appearance and keeping quality for the produce.

FUTURE LINE OF WORK

1) To be repeated in 2 – 3 seasons for confirmation of the results
2) Detailed study on the build up of soil health
3) Assessment of improvement in yield and quality of fruits by applying liquid organic manures (Panchagavya, Jeevamrutham and Fish amino acid) along with adhoc Package of practices by KAU.

SUMMARY

6. SUMMARY

The present investigation on"Nutrient management in organic farming of cucumber (*Cucumis sativus* L.) was carried out in the Agronomy Research Farm of College of Horticulture, Vellanikkara, Thrissur during 2012-2013. Cucumber variety AAUC-2 was used for the study. The summary of the findings is presented below.

1) The organic carbon content of plots receiving organic treatments was increased to a tune of 17%.
2) The highest available N content was recorded in Adhoc POP (534 kg ha^{-1}) which was significantly superior to other treatments. Adhoc POP (FYM + vermi compost + cow dung slurry) recorded the maximum available P (31.37 kg ha^{-1}) and K (314.96 kg ha^{-1}) content.
3) With regard to the soil microbial count at different intervals of crop growth, the treatment receiving *jeevamrutham* and mulching resulted in the highest bacterial and fungal count where as the neem cake application resulted in the highest count of actinomycetes. All the micro organisms were minimum in the treatments receiving chemical fertilizers.
4) The Adhoc POP receiving FYM, vermi compost and cow dung slurry enhanced the growth parameters like vine length, number of leaves and number of branches leading to higher dry matter production.
5) Chlorophyll content (a, b and total) was also highest in the treatment receiving Adhoc POP.
6) The treatment receiving poultry manure + panchagavyam recorded the highest leaf area index during all the crop growing period.
7) The yield parameters like number of fruits per plant, weight of fruit, length of fruits, number of harvest , number of seeds per fruit, fruit flesh thickness were also influenced positively by the organic management.
8) Foliar spray of *panchagavyam* and fish amino acid induced early flowering and fruiting in salad cucumber. The flowering was early as 27 DAS in the treatment receiving poultry manure + fish amino acid against 38 days in N P K alone treatment and 47 days in the absolute control. The fruits could be harvested from the treatment receiving poultry manure + fish amino acid on 35

DAS followed by that receiving poultry manure + *beejamrutham* + *jeevamrutham* + mulching.

9) The treatment receiving Adhoc POP recommendation recorded the highest yield of 53.94t ha^{-1}. An increase in 5.5 t ha^{-1} yield in Adhoc POP than the present POP appear to be due to consistently improved overall growth of plants which resulted higher productivity.

10) The total number of harvests was also more for the treatments receiving organic sources. Adhoc POP receiving FYM, vermi compost and cow dung slurry recorded maximum number of harvest (15) which was significantly superior to all other treatments.

11) The total productive period of the crop was higher in organically treated plots. The period extended up to 98 days in the treatment receiving PM + Fish amino acid as against 77 days in N P K applied plots. The highest shelf life of 8.5 days was also recorded for the same treatment.

12) Increased uptake of N was observed in Adhoc POP treated plots while that of P and K was noticed in the treatment receiving poultry manure + N, P and K, which might be due to steady supply of nutrients and reduced loss from the soil.

13) Mulching was found to provide a beneficial effect on soil microbes likely through buffering the extreme fluctuation in soil moisture and temperature.

14) The organoleptic test revealed that the panelist preferred organically grown cucumber to the chemically grown variant when they assessed the colour, taste, texture, flavuor. Among the organic sources, FYM, vermi compost, poultry manure treated fruits were found to have the best organoleptic qualities among which poultry manure with *panchagavyam* stood first. The overall acceptability was also more for the fruits from the organically treated plots.

15) No incidence of pests and diseases were noted during the crop growth period.

16) The Adhoc POP (FYM + Vermi compost + Cow dung slurry) secured a B : C ratio above 2.5. Even though the cost of cultivation was higher it could be compensated with the increased fruit yield.

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APPENDICES

Appendix I . Physico - chemical properties of soil

Particulars	Content	Method used
Physical properties		
1.Particle size composition		
Coarse sand (%)	30.90	Robinson international pipette method (Piper, 1942)
Fine sand (%)	26.30	
Silt (%)	19.64	
Clay (%)	23.16	
Chemical properties		
1. pH	4.51	1: 2.5 soil water ratio Beckman glass electrode (Jackson, 1958)
2. EC	0.011	Conductometric method (Jackson, 1973)
3. Organic carbon (%)	1.21	Walkley and Black method (Jackson, 1958)
4. Available N (kg/ha)	486	Alkaline permanganate method (Subbiah and Asijah, 1956)
5. Available P (kg/ha)	24	Ascorbic acid reduced molybdophosphoric blue colour method (Watnabe and Olsen, 1956)
6. Available K (kg/ha)	239.4	Neutral normal ammonium acetate extractant flame photometry (Jackson, 1958)

Appendix II. Meteorological data during the crop growing period

Slandared week	Max. Temp. (°C)	Min. Temp. (°C)	Mean RH (%)	Wind speed (km/hr)	Mean sun shine hrs	Rain fall (mm)	Rainy days	Mean evaporation (cm)	Soil Temperature (°C)					
									Morning			Evening		
									5cm	10cm	15cm	5cm	10cm	15cm
48	33.1	22	053	5.0	9.6	000.0	0	4.6	23.8	25.2	26.0	37.5	32.4	31.0
49	33.2	23.6	064	5.8	8.8	006.2	1	4.8	25.7	26.2	27.1	37.6	33.0	31.8
50	33.3	21.5	058	4.8	8.6	000.0	0	4.7	24.6	25.8	27.0	37.5	32.6	31.3
51	31.6	24.2	055	10.7	7.6	000.0	0	6.4	24.9	25.7	26.6	36.2	31.9	30.9
52	33.2	23.6	060	6.1	7.1	013.6	1	5.2	26.0	26.9	27.9	35.8	32.2	31.4
1	34.4	23.0	061	3.6	8.4	000.0	0	4.0	25.7	26.5	27.5	39.2	33.7	32.3
2	33.9	23.0	052	5.4	7.0	000.0	0	4.3	25.9	26.9	27.8	38.3	33.3	31.9
3	33.5	21	048	5.5	9.7	000.0	0	5.2	24.5	25.9	27.0	39.1	33.4	32.0
4	34.5	22.2	041	6.6	9.7	000.0	0	5.9	25.5	26.7	27.9	39.7	33.8	32.5
5	34.2	23.5	051	3.5	9.5	000.0	0	5.4	25.9	27.2	28.3	40.0	34.5	32.6
6	35.0	23.6	061	-----	8.5	000.0	0	4.5	28.4	29.1	29.9	41.4	35.5	34.3
7	34.6	24.4	061	-----	6.9	017.0	1	5.9	28.2	28.8	29.7	39.3	34.3	33.5
8	33.9	23	058	-----	8.8	067.4	1	4.4	25.0	26.0	26.8	36.5	32.8	31.3
9	36.3	21.8	042	-----	10.1	000.0	0	5.6	25.1	26.9	28.1	40.8	35.4	33.8
10	35.1	25.4	061	-----	4.9	007.8	1	5.5	28.4	29.2	30.2	41.1	36.3	35.0
11	35.1	24.3	069	-----	6.9	006.8	1	4.3	27.6	29.0	29.9	42.4	37.3	35.8
12	36.2	24.7	071	-----	8.3	000.0	0	4.8	29.5	30.6	31.7	44.5	38.8	37.8
13	34.6	24.9	072	-----	7.3	000.0	0	4.5	31.0	31.0	32.1	42.9	38.0	36.8

Appendix.III. Physico-chemical and microbial properties of *Panchagavyam*

Properties	Composition	Methods and Author
Total N (ppm)	382	Microkjeldahl-Humphries (1956)
Total P (PPM)	238	Triple acid digestion (colorimetry) - Jackson(1973)
Total K (ppm)	356	Triple acid digestion (flame photometry) – Jackson (1973)
Total sugars (ppm)	205	Nelson somogyis hydrolysis-Somogyi (1952)
Reducing sugars (ppm)	92	
Glucose (mg/dl)	6.0	Glucose oxidase- Malick and Singh (1980)
Total Na (ppm)	92	Triple acid digestion (flame photometry) – Jackson (1973)
Total organic carbon (%)	0.80	Chromic acid wet digestion – Walkey and Black (1934)
IAA (ppm)	9.15	Colorimetry
GA	4.0	
Bacteria (CFU/ml)	24×10^6	Nutrient agar medium – Collings and Lyne (1968)
Fungi (CFU/ml)	1×10^3	Martins rose Bengal agar medium – Martin (1950)
Actinomycetes (CFU/ml)	3×10^3	Ken knights medium – Ken Knight and Muncie (1939)
Pseudomonas (CFU/ml)	45×10^3	Kings B Medium
Yeast (CFU/ml)	35×10^4	Saborauds agar medium
Lactic acid bacteria (CFU/ml)	18×10^5	MRS agar
Methylotrophs (CFU/ml)	5×10^3	Ammonium mineral salt medium

		with methanol
Azospirillum (CFU/ml)	2×10^2	Nitrogen free malate medium
Acetobacter (CFU/ml)	43×10^3	LG medium
Ammonium oxidizes (CFU/ml)	24×10^5	Kings B medium
Nitrite oxidizes (CFU/ml)	2×10^2	
pH	5.12	Glass electrode – Jackson (1973)
EC (dSm^{-1})	9.9	
Zn (ppm)	0.26	DTPA extractant (AAS) – Lindsay and Norvell (1978)
Fe (ppm)	0.83	
Mn (ppm)	0.23	
Cu (ppm)	0.20	
Calcium (ppm)	32-37	
TSS (ppm)	85-115	
Magnesium (ppm)	15-24	
Phenol (mg/g)	0.75	
Lacto basillus (10^6/ml)	20-22	
Anaerobic microbes (10^5/ml)		

Appendix IV. Media used for enumeration of Soil microorganisms

SI NO	Microbes	Dilution for plating	Medium	Reference
1.	Bacteria	10^{-4}	Nutrient Agar	Rao (1986)
2.	Fungi	10^{-4}	Martin's Rose Bengal Agar	Martin (1950)
3.	Actinomycets	10^{-6}	Kenknight and Munaier's Medium	Rao (1980)

Appendix V. Methods followed for Plant analysis

SI.NO	Parameters	Procedure	Reference
1.	Nitrogen	Modified Kjeldhal Digestion method	Jackson (1973)
2.	Phosphorus	Spectrophotometry (Vanadomolybdate yellowcolour method)	Issac and Kerber (1971)
3.	Potassium	Flame Photometry (Neutral Normal ammonium acetate extract)	Jackson (1973)

Appendix VI. Organoleptic evaluation-score card

Name of the judge:

Date:

Characteristics	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}	S_{11}	S_{12}	S_{13}
Appearance													
Colour													
Flavour													
Texture													
Odour													
Taste													
After taste													
Overall acceptibility													

9 Point Hedonic scale

Like extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither like nor dislike	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

Signature

NUTRIENT MANAGEMENT IN ORGANIC FARMING OF CUCUMBER (*Cucumis sativus* L.)

By

RASMI KRISHNAN V.

(2011-11-135)

ABSTRACT OF THE THESIS

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ABSTRACT

A study on " Nutrient management in organic farming of cucumber (*Cucumis sativus* L.) was carried out in the Department of Agronomy, College of Horticulture, Vellanikkara during 2012-2013. The experiment consisted of 13 treatments including different combinations of organic manures and supplements, package of practices recommendation by KAU, inorganics alone and control to develop a nutrient management strategy in organic farming of cucumber. The variety AAUC-2 was used for the study. The organic manures viz., FYM, poultry manure, vermi compost, neem cake and liquid organic manures viz., *Beejamrutham, Jeevamrutham, Panchagavyam* and fish amino acid were the sources of nutrients.

All the treatments receiving FYM as basal dose along with seed treatment with azospirillum, phosphate solubilizing bacteria and Pseudomonas have shown early germination and seedling vigour. Growth parameters like length of vine, number of leaves, number of branches were significantly influenced by the treatments. The treatment receiving poultry manure + N P K recorded the maximum vine length on 45 DAS followed by poultry manure + *Beejamrutham* + *Jeevamrutham* + mulching. Highest number of leaves was produced by poultry manure +fish amino acid treated plants followed by poultry manure + panchagavyam treated ones. The number of branches was also significantly higher in poultry manure + fish amino acid treated plots. The LAI was significantly higher in poultry manure + panchagavyam treated plants.

The flowering was early as 27 DAS in the treatment receiving poultry manure + fish amino acid against 38 days in N P K alone treatment and 47 days in the absolute control. The fruits could be harvested from the treatment receiving poultry manure + fish amino acid on 35 DAS followed by that receiving poultry manure + beejamrutham + jeevamrutham + mulching. Yield and yield attributes like number of fruits per plant, mean fruit weight were also significantly influenced by the application of different organic manures. Highest number of fruits/plant and weight of fruits were observed in Adhoc Package of practices. Highest yield of 53.94 t ha^{-1} was recorded in plots receiving Adhoc package of practices recommendations by KAU (Organic farming) which was 5.5 t more than the present package of practices recommendations by KAU. The total productive period of the crop was higher in

organically treated plots. The period extended up to 98 days in the treatment receiving poultry manure + fish amino acid as against 77 days in N P K applied plots. The highest shelf life of 8.5 days was also recorded for the same treatment.

With regard to the soil microbial count at different intervals of crop growth, the treatment receiving jeevamrutham and mulching resulted in the highest bacterial and fungal count where as the neem cake application resulted in the highest count of actinomycetes. All the micro organisms were minimum in the treatments receiving chemical fertilizers. Statistical analysis by Kendall's test by ranks of the acceptability score revealed that there was significant variation among the treatments in the quality attributes of fruits. The highest score for appearance and colour was also recorded in the treatment receiving panchagavyam followed by the one receiving fish amino acid. The overall acceptability was also more for the fruits from the organically treated plots. The treatment receiving Adhoc POP was found to be significantly superior to other treatments in getting higher gross income, net return and B:C ratio followed by the present POP.