LIQUID FORMULATIONS FOR PRODUCTION OF ORGANIC ORIENTAL PICKLING MELON

(*Cucumis melo* var. *conomon L.)*

By

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(2012-11-194)

THESIS

Submitted in partial fulfillment of the requirement for the degree of

Master of Science in Agriculture

Faculty of Agriculture

Department of Agronomy
Kerala Agricultural University

COLLEGE OF HORTICULTURE

VELLANIKKARA, THRISSUR - 680656
KERALA, INDIA

2014

DECLARATION

I, Vemaraju A. (2012-11-194), hereby declare that the thesis entitled **"Liquid formulations for production of organic oriental pickling melon (*Cucumis melo* var. *conomon* 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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CERTIFICATE

Certified that this thesis entitled **"Liquid formulations for production of organic oriental pickling melon (*Cucumis melo* var. *conomon* L.)"** is a record of research work done independently by **Mr. Vemaraju A. (2012-11-194)** 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 him.

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Dedicated to my family,
M. Chennaiah
(Brohther- in-law),
Venkatesh (uncle)
and
my beloved guide
(Dr. K.E. Usha)

ACKNOWLEDGEMENT

It gives me great pleasure to express my deep sense of gratitude and indebtedness to ***Dr. Usha K.E,*** *Professor and Chairperson of my advisory committee for her inspiring guidance, valuable suggestions, constant encouragement and wholehearted co-operation during the course of this investigation and preparation of thesis. I also place my sincere thanks to her for her patience without which this work would not have been possible. I shall be grateful to her forever.*

My heartfelt thanks are due to ***Dr. C.T. Abraham,*** *Professor and Head, Department of Agronomy for timely suggestions, expert advice, valuable help and critical scrutiny of the manuscript.*

The insightful critiques and ideas of ***Dr. P. A. Joseph*** *(Professor, Department of Agronomy) sparkled and spiked me to move on the right path in the pursuit of this experiment. I sincerely thank him for having devoted his valuable time for providing me proper guidance during the thesis work.*

I extend my cordial thanks to ***Sri. S. Krishnan,*** *Associate professor, Department of Agricultural Statistics for his valuable technical supports during the statistical analysis.*

My profound gratitude is due to ***Dr. K. Surendra Gopal,*** *Associate professor, Department of Agricultural Microbiology for his valuable help and timely correction of the thesis and also thankful for providing necessary facilities for the research work..*

I express my sincere thanks to my beloved teachers of the Department of Agronomy ***Dr. P. S. John, Dr. P. Gopinathan, Dr. George Thomas, Dr. K.E. Savithri, Dr. Meera. V. Menon, Dr. Lalithabai, Dr. A. Latha, Dr. Sindu*** *and* ***Dr. Anitha*** *for their expert teaching, whole hearted co-operation and readiness to help.*

I convey my heartfelt thanks to ***Dr. Sujatha,*** Scientist (Soil Science) *KFRI,* ***Dr. Latha,*** *Associate Professor, Department of Public Health and Animal Science (KVASU),* ***Dr. Nandini,*** *Professor and Head,* ***Dr. T. Girija,*** *Professor, Department of Plant Physiology,* ***Dr. Ajith Pillai,*** *Associate Professor, Department of Agricultural Meteorology and* ***Dr. D. Girija*** *Professor and Head Department of Agricultural Microbiology for all sort of help rendered by them for the completion of this research.*

I convey my deeply thanks to ***Dr. P. K. Sushma,*** *Professor and Head,* ***Dr. Srilatha,*** *Assistant Professor,* ***Sri Visveswaran*** *Assistant Professor, Department of Soil Science & Agricultural Chemistry,*

My special thanks to ***Sreela chechi, Rajitha chechi, Bejoy chetan, Jitin chetan, Arun*** *and the non teaching staff members of the Department of Agronomy for their sincere co-operation and assistance rendered during the course of investigation.*

I convey my deeply thanks to ***Deepa chechi, Aruna chichi, Sandhya chechi, Saritha chechi, Raziya chechi, Soumya chechi, Praveen chetan, Sudhee rchetan Mujeeb chetan*** *and also all other staff members of ATIC, Mannuthy for their sincere co- operation and assistance rendered during the course of investigation.*

I am deeply thankful to ***Devan chettan, Sashi chettan, Suresh chettan, Vasantha chechi, Sheena chechi, Shyama chechi, Mercy chechi, Ajitha chichi*** *and other labourers, Agronomy Farm for their whole hearted co-operation and sincere efforts for the successful completion of my investigation.*

Words fail to express my deep sense of gratitude and indebtedness to ***my parents, M. Chennaiah (Brother In-law), B.Venkateshwarlu (Uncle), Dr. Sreenivas (Uncle)*** *and for their constant encouragement, physical and mental help and sincere efforts without which I could not have completed the thesis work.*

Hearty thanks to ***my sister, brother*** *and other* ***family members, relatives and friends*** *for their prayers, inspiration and moral support for making this endeavour a success.*

I am deeply thankful to KAU for providing junior fellowship and research fund.

I am extremely thankful to my dear friends ***Mr. Ramanarayana, Mr.Veeresh, Mr. Basavaraj, Mr. Prasad, Mr. Deepak, Mr. Subramanyam, Mr. Amarnath Reddy, Mr. Vikram, Mr. Harikumar, Mr. Ajay Bharathwaj, Mr. Naveen kumar, Mr. Naresh, Mr. Ajith, Mr. Arun, Mr. Faraz Mahmad, Batch mates, junior friends*** *and Pamba mens hostel residents who helped with whole hearted co-operation and sincere efforts for the successful completion of my investigation.*

Hearty thanks to my batch mates ***Miss. Shobha rani, Miss. Sangamitre, Miss. Anila antony, Miss. Sajeera, Miss. Harsha narayanan,*** *and seniors* ***Miss. Asha Pillai, Miss. Shayama Miss. Savitha and*** *juniors for their help.*

Hearty thanks to seniors ***Mr. Subba Reddy, Mr. NingaRaju, Miss. Chandhini, Miss. Geethu, Miss. Neethu Miss. Nissa*** *and special thanks to* ***Miss. Reshmi Krishnan*** *for their sincere co- operation and assistance rendered during the course of investigation.*

Above all I worship the ***GOD*** *for the blessings showered upon me.*

VEMARAJU A.

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LIST OF ABBREVIATIONS

%	-	Percent
@	-	At the rate of
^{o}C	-	Degree celsius
B: C	-	Benefit cost ratio
cm	-	Centi meter
cfu	-	Colony forming unit
CRD	-	Completely Randomized Design
RBD	-	Randomized Block Design
DAS	-	Days after sowing
DMP	-	Dry matter production
dSm^{-1}	-	Decisiemen per meter
EC	-	Electrical conductivity
et al	-	And others
i. e	-	That is
L	-	Liters
kg	-	Kilogram
kg ha^{-1}	-	Kilogram per hectare
M	-	Meter
MSL	-	Mean Sea Level
N	-	Nitrogen
P	-	Phosphorus
K	-	Potassium

Introduction

1. INTRODUCTION

Organic farming is gaining importance in recent years due to realization of inherent advantages it confers in sustainable crop production and also in maintaining dynamic soil nutrient status and safe environment. Finding new perspectives for reducing chemical inputs in agriculture and their residues in food has become one of the major thrust areas of research.

Maintaining favourable soil physical, chemical and biological condition is the need of the hour. It has been estimated that the soil organic carbon content in India has drastically reduced from 1.2% to 0.6% in 2000 and is declining further (Devasanapathy *et al.,* 2008).The unscientific and indiscriminate use of agrochemicals has affected the soil health adversely and brought down the productivity of the soil by destroying natural soil micro organisms like *Rhizobium* and Phosphorus Solublizing Bacteria (PSB) resulting in stagnation of crop productivity (Dademal and Dongale 2004).

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. Use of heavy dose of fertilisers for topdressing can affect the nutrient content and keeping quality of vegetables. The high cost of chemical fertilizers also limits their application in vegetable cultivation. As the cultivation of vegetables in homesteads and terrace is gaining popularity, there is a need for an organic phytotonic to substitute chemical fertilizers.

Most of the vegetables contain pesticide residues more than the permissible limits which lead to various kinds of health hazards (Hansen, 1996). 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.Use of liquid formulations as foliar spray is gaining importance in crop production owing to its quick response in plant growth. Foliar feeding of nutrients is available supplement to conventional soil application and it entails the spraying of nutrients to plant leaves and stems and their absorption through those sites. Foliar feeding has proved to be the fastest way of curing nutrient deficiencies and boosting plant performances at specific physiological stages. With plants competing with weeds, foliar spraying focuses the nutrient application on the target plants.

Jeevamrutham, Panchagavyam, Fish amino acid, Green leaf extract, Vermiwash, Cow urine etc. are some of the liquid organic formulations used in organic farming. Liquid organic manures improve plant growth directly through nutrient mobilization, production of plant growth hormones and indirectly through suppression of plant pathogens or by inducing systemic resistance in plants. According to Mishra and Gopalakrishnan (2010), use of liquid organic manures is an integral part of organic farming. Liquid formulations add much needed organic and mineral matter to the soil and play an important role in the buildup of soil organic matter, beneficial microbes and enzymes besides improving physical and chemical properties of soil (Revusehab, 2008).

Cucurbits are the largest group of summer vegetable crops. Growing oriental pickling melon in summer rice fallows is a common practice in Kerala. It is consumed as raw or cooked vegetable. Saubhagya variety has gained wide acceptance among farmers due to its attractive golden colour which are preferred for preparing “Vishukani”.

The studies conducted by Krishnan (2014) on salad cucumber revealed the superiority of application of FYM, vermicompost, and fresh cow dung slurry

as per the package of practices recommendations (Adhoc) for organic farming by KAU. Hence the present study on "Liquid formulations for production of organic oriental pickling melon (*Cucumis melo* var. *conomon* L.)" was undertaken with the following objectives.

- To study the effect of seed treatment with liquid formulations on germination and seedling vigour in oriental pickling melon
- To compare the efficiency of liquid organic manures on growth, yield and quality in oriental pickling melon under organic farming
- To estimate the characteristics of liquid organic formulations
- To compare the economics of crop production with liquid formulations

Review of Literature

2. REVIEW OF LITERATURE

India has vast potential of organic resources and the extract prepared from these resources can be effectively utilized to sustain yield, improve physical, chemical and biological properties of soil and to maintain soil health. Regular additions of organic manure in sufficient quantities help in the maintenance of organic matter content at optimum levels (Thampan,1993).Organic source of nutrients conserve the soil health by maintaining the equilibrium of organic matter and soil micro flora (Walia and Kler, 2007).

The review of literature pertaining to the study on "Liquid formulations for production of organic oriental pickling melon (*Cucumis melo* var. *conomon* L.)" is presented below.

2.1 LIQUID FORMULATIONS

Liquid organic manures play an important role in enhancing soil and crop productivity. Commonly used liquid formulations are Panchagavyam, Jeevamrutham, Fish amino acid and Green leaf extract.

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 % SO3 ,1.5 % Silica ,0.5 % N ,0.2 % P and 0.5 % K (Singh, 1996).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 (Natarajan, 2003).

Nutrient analysis of Jeevamrutham by Sreenivasa *et al.* (2011) indicated the presence of major nutrients like nitrogen (770-1000 ppm), phosphorous (166-175 ppm), potassium (126-194 ppm) and minor nutrients like zinc (1.27-4.29 ppm),copper (0.38-1.58 ppm), iron (29.7-282 ppm) and manganese (1.8-10.7 ppm).

2. 1. 2 Effect of liquid formulations on production of growth promoting hormones

According to Booth (1965),seaweed liquid extract contain growth promoting hormones like auxins (IAA and IBA), cytokinins, gibberellins, trace elements, vitamins, amino acids, antibiotics and micronutrients for achieving higher agricultural production. Metha *et al.* (1967) reported that the liquid extract of seaweeds popularly known as seaweed liquid fertilizers could be used as foliar spray for inducing faster growth in cereals, vegetables, fruits, orchards and horticultural plants. Kannan and Tamilselvan (1990) found that soil application of seaweed liquid fertilizer of *Enteromorpha clathrata* and *Hypnea musciformis* increased the growth characteristics of green gram, black gram and rice.

Effective Microorganisms (EM), a mixture of live cultures of microorganisms isolated from fertile soils in nature, is found to be useful for crop production. EM preparations generally contain *Lactobacillus*, photosynthetic bacteria, yeasts and other beneficial microorganisms which increase the crop growth (Yamada *et al*., 2003).

Ingham (2003) reported that compost tea contained soluble nutrients that enhanced crop growth when applied as foliar spray. Ryan (2007) also observed that the health and growth of crops was improved by foliar application of compost tea.

According to Palekar (2006), Beejamrutham is a source of nutrients used for seed or seedling treatment to increase the germination capacity of seeds and growth

of seedlings. Several beneficial bacteria are also present in Beejamrutham and inoculation of these bacterial isolates resulted in improvement of seed germination, seedling length and vigour in soybean. Organic seed fortification with *Jatropha curcas* and *Pongamia pinnata* using Panchagavya at different concentrations with three different soaking durations gave good germination (Srimathi *et al*., 2013).

Beejamrutham contains several hormones which promote the growth of plants (Palekar, 2007). According to Sreenivasa (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).

According to Mohan*et al*. (2008), organic promoters like Panchagavya and EM solution enhanced the yield of brinjal. Chandrakala(2008) opined that combined application of liquid manures like Beejamrutham, Jeevamrutham and Panchagavya will significantly enhance the growth in chilli seedlings. The experiment conducted by Gore (2009) revealed that combined application of Beejamruth, Jeevamruth and Panchagavya on 75 and 160 days after sowing of tomato increased the enzymatic activities, plant growth, root length and N, P and K concentration.

Sangeetha *et al*. (2010) reported highest nodule formation in soil amended with low levels of seaweed based Panchagavya (Panchagavya: soil in 1: 100 ratio) in the case of pulse crops.

2.1.3 EFFECT OF LIQUID FORMULATIONS ON CROP NUTRITION

Palekar (2007) opined that the availability and uptake of nutrients by crops could be increased by the application of Jeevamrutham. 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 the soil. Combined use of organics (FYM, vermi compost, biofertilizers and Panchagavyam) resulted in higher uptake of major nutrients in chilli (Kondapa naidu *et al.,* 2009).

2. 1. 4 EFFECT OF LIQUID FORMULATIONS ON GROWTH, YIELD AND QUALITY OF VEGETABLES

2.1.4.1Effect on growth and yield

Dahiya and Vasudevan (1986) reported that the application of biogas slurry was beneficial in replacing half of the fertilizer nitrogen and to produce better yield in vegetables. Kungkaew *et al*. (2004) observed that bio gas slurry along with chemical fertilizers in 1:1 ratio was effective in improving the crop yields of sweet corn, tomato and strawberry.

Studies were conducted by Ramasamy *et al*. (2010) on the comparative effects of vermicompost, FYM, sea weed *(Hypnea muciformis* Lamour) and liquid manures individually and in combination on morphology and yield in okra variety Kumuda 501. The increased LAI and fruit weight were noticed in vermicompost and vermicompost + liquid manures treated plants.

Buckerfield *et al.* (1999) found that weekly applications of vermiwash increased radish yield by 7.3 %. Yield improvement in tomato by soil application of vermiwash @12.5 % concentration was reported by Jasmine (1999). Studies by Lozek and Gracova (1999) revealed that application of vermisol increased yield by 7.3 % in chilli.

Lalitha *et al.* (2000) observed that application of organic inputs like vermicompost in combination with vermiwash resulted in better yield of crops by slow release of nutrients for absorption and supplementation of gibberellins,

cytokinins and auxins. Vermiwash at 50 % concentration along with full NPK applied plots produced maximum number of seeds per fruit. The highest fruit yield of 18.35 t ha $^{-1}$ was recorded by the same treatment.

Nishana (2005) reported that soil and foliar application of vermiwash @ 50 ml plant^{-1} registered maximum yield in bhindi. Chandrakala (2008) noticed that the combined application of Beejamrut, Jeevamruth and Panchagavya increased the yield and drymatter production in chilli. The yield of brinjal could be increased by 33 % by the application of organic promoters like Panchagavya and EM solution (Mohan and Srinivasan, 2008).

Application of a combination of Beejamrutham, Jeevamrutham and Panchagavyam (1:1:2) on 75 and 160 DAS increased the yield of tomato (Gore, 2009).

In Panchagavyam, proven biofertilizers such as *Azospirillum, Azotobacter*, Phosphobacteria and *Psuedomonas* were found besides *Lactobacillus (*Solaiappan, 2002). Malathy (2003) observed that tomato showed greater response for the application of Panchagavyam. Panchagavya was tested for different crops such as turmeric, paddy, onion, gingelly, sugarcane, banana, vegetables and curry leaf and it was found to enhance the growth and vigour of crops, resistance to pests and diseases and also improve the keeping quality of vegetables and fruits (Natarajan, 2003).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 (71) followed by 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).

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.

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. 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 acetate0.5% + Panchagavyam5% 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.

The number of flowering panicles per tree and number of flowers per panicle and fruit yield were increased by the application of a combination of organic manures like poultry manure (500gm), neem cake (250gm) and Panchagavyam2%

(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). Natarajan (2003) implied that a 3% spray of Panchagavyam on Yazhpanam moringa before the end of flowering stage produced 1000 fruits per harvest.

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.

Studies conducted by Sadanandan and Drand (2006) during 2005-2006 at IGFRI, Jhansi revealed that all the jaivic and vedic krishi inputs like amritpani, Panchagavya and gomuthra improved the crop productivity, soil microbial population and biological activity.

Experiments conducted by Abdulla and Sukhraj (2010) revealed that combined application of vermicompost and vermiwash is beneficial in improving the growth and yield of bhindi. 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 and ultimately the yield.

Organic promoters like Panchagavyam and EM solution enhanced the yield of brinjal (Mohan and Srinivasan, 2008). Combined application of liquid manures like Beejamruth, Jeevamruth 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).

Abhilash (2011) reported 20% increase in growth and yield and improved the colour of red amaranthus with foliar spray of fish amino acid.

2.1.4.2 Effect of liquid organic manures on 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 (Kumaran *et* al., 1998).

Bhadoria *et al*. (2002) could obtain superior results for organoleptic quality, storage quality, content of vitamin C and sugars when compost was applied to crops like tomato, rice, okra and cabbage.

Adams (1986) reported that vermiwash application had a positive effect in bringing colour to tomato fruits due to the presence of nitrogen and other micronutrients which enhanced the synthesis of lycopene. Whapham *et al*. (1993) observed that the application of seaweed extract of *Ascophyllum nodosum* increased the chlorophyll levels of cucumber cotyledons and tomato plants.

Linder (1985) found that the respiration rate and enzyme activity were lower in organically produced vegetables leading to reduced storage losses. 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.

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.

Zaller (2006) noticed that foliar application of vermicompost leachate improved lycopene content in tomatoes. Shivamurthy and Patel (2006) noticed the effectiveness of cow's urine for seed treatment in enhancing the chlorophyll a and chlorophyll b content thereby contributing to yield improvement in wheat. Ryan (2007) opined that the quality of crop produce could be improved by the application of compost tea.

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

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 contents between the organically 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 $^{-1}$, vermicompost @ 10 t ha $^{-1}$, FYM (50%) + vermicompost (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.

According to Mohanand Srinivasan (2008), foliar application of organic promoters like Panchagavya and EM solution increased the quality of fruits. Gore (2009) reported that use of Beejamruth+ Jeevamruth+ Panchagavya at 75 DAS and 160 DAS as foliar spray increased the lycopene content in tomato.The experiment conducted by Krishnan (2014) 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.

Singh (2011) noticed that the organic manures could sustain the soil fertility and maintain crop productivity in okra. The growth, yield and quality of produce was significantly influenced with organic treatments such as poultry manure, Panchagavyam, fish amino acid, fermented leaf extract and fermented oil cakes compared with inorganic fertilizer (POP). Liquid organic manures significantly increased growth and yield in okra and amaranthus. (Pillai, 2012) and also increased the shelf life and quality of these vegetables. Sihi *et al.* (2012) noticed better quality and productivity of organic basmati rice compared to that in conventio*al* farming.

In short, liquid organic manures increase the quality and appearance of fruits and vegetables and also reduce the ill effects of poisonous chemicals.

2.1.5. EFFECT OF LIQUID ORGANIC MANURES ON MICROBIAL ACTIVITY

According to Palekar (2006) the enormous amount of microbes present in Jeevamruth enhanced the microbial activity in soil. Ryan (2007) also

opined compost tea as one of the liquid manures for enhancing microbial activity of soil.

Ingham (2005) reported the presence of several beneficial microorganisms in compost tea. He also observed that greater the amount of soluble material in the compost tea, the more food resources would be there for the growth of beneficial bacteria and fungi, and microbial activity will be improved.

Studies conducted by Sreenivasa *et al.* (2009) revealed that the beneficial micro organisms in Beejamrutham enhanced the microbial activity of the soil. Microbial load and nutrient status of Panchagavya and Jeevamrutha was estimated by Sreenivasa *et al.* (2011). Total bacteria, fungi and actinomycetes in Panchagavya and Jeevamrutha were 20.4-26.1 x 10^5 cfu/ml, 13.8-18.0 x 10^4 cfu/ ml and 3.6-4.2 x 10^3cfu/ml respectively. In addition to that, microbes like nitrogen fixers and P solubilizers (2.7-5.0 x 10^2 and 3.6-4.2x 10^2cfu/ml respectively) were also estimated from these organic formulations.

Gopal *et al*. (2010) reported that application of coconut leaf vermiwash increased the population of soil microorganisms, particularly plant beneficial ones, and their activities facilitated increased uptake of the nutrients.Kumar and Singaram (2011) reported increase in dehydrogenase, urease and catalase activity in soil by the application of Panchagavya @ 3% as foliar spray.

The microbial activity of soil could be improved by the application of liquid manures due to the enormous amount of beneficial microbes (mainly bacteria and fungi) present in it.

2. 1. 6 EFFECT OF LIQUID FORMULATIONS ON INCIDENCE OF PEST AND DISEASES ON CROPS

Sweet pepper grown under organic culture was reported to have high levels of phenolic compounds and the peroxidase and capsidiol activity which had contributed to disease resistance (Francisco *et al.,* 2008).

Bahadur *et al.* (2007) reported that foliar application of PGPR increased anti-fungal compounds in pea (*Pisum sativum*) against powdery mildew pathogen *Erysiphepisi.*

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 %).

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) observed that 5% spray of Panchagavyam could control bacterial blight of paddy. Sreenivasa (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 were observed by using a modified formulation of Panchagavyam ended sea weed extract (Sangeetha *et al.*, 2010).Vallimayil and Sekar (2012) found that using Panchagavya for seed treatment and foliar spray on Southern Sun hemp Mosaic Virus infected sun hemp plants gave good results.

Nene (1999) opined that 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.

Weltzien (1992) reported the effectiveness of compost tea as surface spray for the control of foliar diseases of plants. Compost tea could reduce the severity of diseases like powdery mildew and downy mildew of grape, grey mould of strawberries and late blight of potato.Scheuerell *et al.* (2002) observed that compost tea as foliar spray could reduce the incidence of pests and diseases in crops by competition with disease causing microbes and degradation of toxic pesticides.According to Sayre (2003), compost tea had the capacity to manage many pests and diseases of crop plants. Ingham (2003) opined that the plant exudates, both from roots and leaves, enhanced the disease - suppressive bacteria and fungi that occur in aerobic compost tea.

Scheuerell (2003) noticed that non aerated compost tea preparation takes longer time for fermentation. This enabled accumulation of antibiotics in the non aerated compost tea which activate natural plant defence responses thereby help in disease suppression.Verngrubinger (2005) observed that compost tea was helpful to fight off diseases by inoculating plants with beneficial micro organisms.

An improvement in pest and disease resistance due to the application of EM in vegetables was noticed by Tuat and Trinh (2002).

Giraddi *et al*. (2003) reported a significant reduction in pest population and leaf curl index in chilli treated with vermiwash (soil drench30days after transplanting and foliar sprays at 60 and 75 days after transplanting). Subashri (2004) established the suitability of vermiwash as an effective bio pesticide in many vegetable crops.

Complete suppression of mycelial growth of *Sclerotiana sclerotiorum* in cucumber was possible by the addition of different herbal plant extracts with fresh cow's urine and cow dung (Basak *et al.,* 2002). Khoa *et al*. (2010) found that foliar spraying and

seed soaking of extracts of either fresh or dried leaves of *Chromolaena odorota* gave up to 68% reduction in sheath blight under controlled and field conditions.

2.2 ORGANIC MANURES

Pimenlala *et al.* (1984), comparing organic and inorganic grain production system, had 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 with oxygenated peptone for soil conditioning. He reported the improvement in enzyme activity of catalase, peroxidase and polyphenol oxidase. Moreover better shelf life, superior taste and better shining of fruits increased its marketability.

2.2.1 Effect of organic manures on crop growth and nutrition

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 $^{-1}$. Channabasavanna and Birdar (2002) reported that the nutrients present in poultry manure are 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}.

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.

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 the uptake of N (ranged from 0.08 to

0.13 g plant, 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 increase in the yield.

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. According to Singh (2004), the treatment having FYM with other bulky organic manures gave the highest yield in okra.

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. 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 experiment conducted by Bonde *et al.* (2004) 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}) values 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 invertisols.

2.2.2 Farm yard manure as the source of nutrients

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 found that nitrate nitrogen concentration of the vegetable decreased with decrease in nitrogen application, where as the total sugar content increased.

Bhadoria *et al*. (2002) noticed an increase in protein content, total minerals and ascorbic acid content with the application of FYM in Okra. 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. Yadav and Chhipa (2007) found that the grain and straw yield of wheat increased significantly with the successive increase in the level of FYM.

2.2.3 Poultry manure as the source of nutrients

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 were 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 even40 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 (Br*assica chinesis)* due to the application of poultry manure. Improved growth in okra variety VarshaUpahar 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).

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 (Odeleye *et al.*, 2005). Poultry manure was the most economical in the study on organic nutrient scheduling for okra and cowpea conducted by Geethakumari *et al* .(2009). In Egypt, higher yield was recorded with poultry manure when compared to plant residues (El-Kader *et al.*, 2010).

Sangeetha and Ganesan (2010) reported the beneficial effects on seed germination and yield in green gram by the application of organic inputs like cow dung, goat manure, poultry manure, leaf compost and FYM.

2.2.4 Organic manure and soil health

Organic source of nutrients conserve the soil health by maintaining equilibrium of organic matter and soil micro flora. Addition of organic manures like FYM, poultry manure, vermicompost, coir pith compost and oil cakes improve the physical, chemical and biological properties of soil and thereby enhance the productivity of soil. 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. Hangarge *et al.* (2004) reported higher organic carbon content, lower pH and EC with the combined application of vermicompost @ 5t ha^{-1} and cow dung slurry and organic booster @1L/m^2.

Ravishankar *et al*. (2008) found that different organic manuring treatments gave significantly higher microbial population (fungi, bacteria and actinomycetes) and enzymatic activities in the soil and the application of FYM (20 kg / plant) was the best for improving soil quality. Radhakrishnan (2009) observed appreciable count of beneficial microorganisms like *Psuedomonas, Azospirillum*, PSB, yeast, moulds and actinomycetes in vermicompost. Prasantharajan *et al*. (2009) also

noticed 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 neemcake significantly contributed to the improvement in soil microbial load in maize - rice - green gram cropping system at Tanjavur.

From the above reviews it is clear that liquid manures as foliar sprays could increase the yield of crops in several ways viz. by supplying a part of nutrient requirement, providing soluble nutrients at correct time, increasing the pigment content in the plant and producing more dry matter.

Materials and Methods

3. MATERIALS AND METHODS

The present investigation on "Liquid formulations for production of organic oriental pickling melon (*Cucumis melo* var. *conomon* L.)" was carried out in College of Horticulture, Kerala Agricultural University, Vellanikkara, Thrissur during 2013-2014.

3. 1. General details

3. 1. 1 Experiment: I

Effect of seed treatment with liquid formulations on germination and seedling vigour in oriental pickling melon

3.1.1.1 Experimental site

The experiment was conducted in the green house of Agricultural Technology Information Centre (ATIC), Mannuthy.

3.1.1.2 Time of experiment

The experiment was conducted from 22nd November to 7thDecember, 2013.

3. 1.2 Methods

3. 1. 2.1 Crop and variety

The oriental pickling melon variety "Soubhagya", recommended for cultivation by KAU, was used for the study.

3. 1. 2.2 Technical programme

Treatments - 8

Design - CRD

Replications - 3

No of pots /Replication - 10

Plate 1. Seed treatment and sowing operations

Seed treatment with liquid formulations

Sowing in polythene bags

Plate 2. Preparation of Panchagavyam

Cowdung and ghee mixing

Stirring of Panchagavyam

Panchagavyam

Plate 3. View of the experimental field

View of the Field

Field view at 15 DAS

3. 1. 2. 3 Treatments

T_1 - Cow dung slurry (1: 2)

(1part cow dung: 2 parts water)

T_2 - Cow urine (5%)

T_3 - Panchagavyam (30%)

T_4 - Beejamrutham (100%)

T_5 - *Pseudomonas fluorescens* (KAU culture)(5%)

T_6 - (T_3 + T_5)

T_{7-} (T_4 + T_5)

T_{8-} Control (Water)

Methods of preparation of Beejamrutham and Panchagavyam are as follows.

Beejamrutham

Fifty grams of slaked lime and 500g undisturbed soil was added to 25 liters 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 (Palekar, 2007).

Panchagavyam

Seven kilograms of cow dung and one kilogram of ghee were mixed in a clean container thoroughly stirring both in morning and evening hours and kept aside for 3 days. After three days, ten liters of cow urine and ten liters of water were added. The mixture was kept for 15 days with regular mixing both in morning and evening hours. After 15 days, three liters of cow milk, two litres of curd, three liters of tender coconut water, three kilograms of jaggery and 12 numbers of well ripened

palayankodan bananas were also added and mixed well. Panchagavyam was sprayed on 22ndday at a concentration of 3% (Package of practices recommendations (Adhoc) for organic farming: Crops, 2009).

Seeds were soaked overnight as per the treatments and sown in washed sand medium next day. The growth was observed for 15 days. The growth of radicle and plumule was measured and the fresh and dry weights were recorded by destructive sampling at 7 DAS and 15 DAS.

3. 1. 2. 4 Observations

3. 1. 2. 4.1 Germination percentage

The number of days taken for germination was noted and the percentage of germination was recorded at4 DAS and 7 DAS.

3. 1. 2. 4. 2 Time taken for emergence of radicle

The time taken for emergence of radicle in each treatment was observed.

3. 1. 2. 4. 3 Time taken for emergence of plumule

The time taken for emergence of plumule in each treatment was noted.

3. 1. 2. 4. 4 Length of radicle

The length of radicle in each treatment was measured by destructive sampling at 7DAS and 15 DAS.

3. 1. 2.4. 5 Length of plumule

The length of plumule in each treatment was measured by destructive sampling at 7DAS and 15 DAS.

3.1.2.4.6 Fresh weight

The whole plant fresh weight in each treatment was recorded (mg plant $^{-1}$) by destructive sampling at7DAS and 15 DAS.

3.1.2.4.7 Dry weight

The whole plant with leaves, stem and roots were oven dried at 50± 5^0 C to constant weight. The final dry weight was recorded (mg plant $^{-1}$) at7DAS and 15 DAS.

3.1.2.4.8 Vigour Index

Vigour index - I was calculated using the formula described by Baki and Anderson (1973) as follows.

Vigour index I = Total length of seedling X Germination percentage

3.2 Experiment: II

Evaluation of liquid organic manures on growth and yield of oriental pickling melon

3. 2. 1 Experimental site

The experiment was conducted in the Agronomy 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.

3.2. 1.1Soil

The soil of the experiment site was sandy clay loam in texture (Order: ultisol). Physico- chemical properties of the soil are given in the Appendix I.

3.2. 1. 2Climate

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

3.2. 1. 3Season of the experiment

The experiment was conducted from December, 2013 to March, 2014.

3. 2. 2 METHODS

3. 2. 2. 1Crop and variety

The variety "Saubhagya" of oriental pickling melon was used for this study. The fruits are small to medium in size with uniform oblong shape. The developing fruits are green with light green lines and turns attractive golden yellow on ripening. Specific advantage of the variety is its short duration (60-65 days), less vegetative growth and small to medium sized attractive fruits.

3. 2. 2.2. Technical programme

Treatments -11

Design -RBD

Replications -3

Spacing - 2 m X 1.5 m

Plot size - 4 m X 3 m

3. 2. 2.3 Treatments

T_1 - Jeevamrutham (100%) (Weekly spray)

T_2-Panchagavyam (3 %) (Weekly spray)

T_3-Fish amino acid (1%) (Weekly spray)

Plate 4. Different operations

Sowing

Preparation of liquid formulations

Irrigation

Spraying of liquid formulations

Cow dung slurry preparation

Harvesting

Plate 5. Different stages of the crop

Germination

15 DAS

Flowering

Fruiting

Harvesting

T_4 - Cow urine (5%) (Weekly spray)

T_5 - Green leaf extract (10%) (Weekly spray)

T_6 - T_2+ T_3 + T_5 (Weekly spray)

T_{7-} Control (with water spray)

T_8 - Control (without water spray)

T_9- 20t FYM/ha + NPK 75:25:25 kg /ha (POP recommendations of KAU)

T_{10}- Liquid extract of composite organic manures (20 %) {Groundnut cake + Neem Cake + Poultry manure (1: 0.5: 0.5)}

T_{11}- Commercial formulation (Biozyme) (1%)

Methods of preparation of Jeevamrutham, Fish amino acid, Green leaf extract and Liquid extract of composite organic manures are as follows.

Jeevamrutham

Ten kilograms of cow dung, ten liters of cow urine, two kilograms of green gram (germinated and ground), 500gundisturbed soil and two liters of coconut water were added to 200L water and mixed well. Stirring was done twice a day in clock wise direction and was applied on 7^{th}day (Palekar, 2007).

Fish amino acid

One kilogram of fish and two kilograms of jaggery were mixed properly and kept it an air tight container for 21 days without any disturbance.10 ml of Fish amino acid was diluted with one liter of water and sprayed.

Green leaf extract

Two kilograms each of the leaves of Gliricidia (*Gliricidia sepium*), Chromolaena (*Chromolaena odorata*), Neem (*Azadirachta indica*), Datura (*Datura metal*) and Lantana (*Lantana camera)* were dipped in 200 L of water for 10 days. It was diluted 10 times and sprayed.

Liquid extract of composite organic manures

Groundnut cake, neem cake and poultry manure mixed in the ratio of 1: 0.5: 0.5were soaked in water (1:5) for 7 days and sprayed after diluting 5 times.

3. 2. 3 Cultural operations

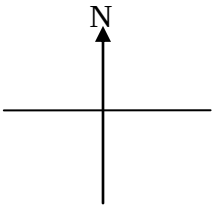
The experimental area was ploughed, leveled and pits were taken (60 cm diameter and 30 cm depth) at a spacing of 2 m X 1.5 m. Seeds were sown @ 5 per pit. Gap filling and thinning were done to secure a uniform stand of the crop (3 plants / pit). Weeding was done as and when required. Nutrients were given as per the schedule mentioned in the treatments.

Seeds for all the treatments except T_9were soaked in *Pseudomonas* (10g L^{-1}) and Panchagavyam (300 ml L^{-1}) based on the results of experiment I. All the treatments except T_9 were given basal and top dressing applicaton of organic manures as per the Package of practices recommendations (Adhoc) for organic farming : Crops. Poultry manure @4t/ha and neem cake and ground nut cake @250kg/ha were applied as basal. Coir pith compost @8t/ ha was given two times at winding and flowering stages.Cow dung slurry application was done at fortnightly intervals from flowering.

Liquid formulations were applied as foliar spray at weekly intervals from seventh day after sowing onwards.

The lay out plan of the experiment is presented in Figure 1.

Fig.1.Layout plan of the experimental field



T2	**T_4**	Blank		**T_8**	**T_{10}**	**T_4**		**T_7**	**T_5**	**T_9**
T_3	**T_5**	**T_{11}**		**T_2**	Blank	**T_6**		**T_1**	**T_2**	**T_4**
T_6	**T_8**	**T_{10}**		**T_1**	**T_5**	**T_3**		Blank	**T_{10}**	**T_3**
T_9	**T_7**	**T_1**		**T_7**	**T_9**	**T_{11}**		**T_8**	**T_6**	**T_{11}**
R1				**R2**				**R3**		

T_1 – Jeevamrutham (Weekly spray)

T_2-Panchagavyam (Weekly spray)

T_3-Fish amino acid (Weekly spray)

T_4 - Cow urine (Weekly spray)

T_5 - Green leaf extract (Weekly spray)

T_6 - T_2+ T_3 + T_5 (Weekly spray)

T_7 -Control (with water spray)

T_8 -Control (without water spray)

T_9- 20t FYM/ha + NPK 75:25:25 kg /ha (POP)

T_{10}- Liquid extract of composite organic manures {Groundnut cake + Neem cake + Poultry manure (1: 0.5: 0.5)} (Weekly spray)

T_{11}- Commercial formulation (Biozyme) (Weekly spray)

3.2.4 Observations

Four 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. 2.4.1 Soil characteristics

Soil characters before the experiment were estimated using appropriate methods. Soil samples were collected separately from each experimental plot at the end of the experiment. The soil samples were air dried and analyzed for physical and chemical characteristics.

3. 2.4.2 Total Microbial population in soil

The microbial count of the experimental soil were enumerated before the experiment, 15 DAS and 30 DAS .The method used for the enumeration was serial dilution and plate count technique (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 III. 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 (2-3 days for bacteria, 5-7 days for fungi and 3-14 days for actinomycetes).

3.2.5 Characteristics of liquid formulations

Liquid formulations viz. Jeevamrutham, Panchagavyam, Fish amino acid, Green leaf extract and Composite organic manures were analyzed for the characteristics of pH, EC, NPK content and total microbial count.

3.2.6 Growth characters

3.2.6. 1 Germination percentage

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

3. 2.6. 2 Length of vines

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

3. 2.6. 3 Number of leaves

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

3. 2.6.4 Duration of the crop

The number of days taken from sowing to the last harvest of the crop was recorded.

3. 2.6.5 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. 2.6.6 Days to first harvesting

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

3. 2.6.7 Number of harvests

The total number of harvests was recorded.

3. 2.6.8 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. 2.7 Physiological characters

3. 2.7.1Chlorophyll content

Total chlorophyll content in the leaves was estimated at 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. Finely cut sample (0.1g) 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 15 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).

$$\text{Chlorophyll a (mg/g)} = 12.7 \times \text{OD at 663 nm} - 2.69 \times \text{OD at 645 nm} \times \frac{V}{1000 \times W}$$

$$\text{Chlorophyll b (mg/g)} = 2.9 \times \text{OD at 645 nm} - 4.63 \times \text{OD at 663 nm} \times \frac{V}{1000 \times W}$$

$$\text{Total Chlorophyll (mg/g)} = 8.02 \times \text{OD at 663} + 20.2 \times \text{OD at 645} \times \frac{V}{1000 \times W}$$

Plate 6. Observations during crop growing period

Soil sample collection at 15 DAS

Biometrical observation at 30 DAS

Visit of faculty members to the field

3. 2.8 Yield and yield attributes

3. 2.8.1 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. 2.8.2 Volume of fruits per plant (cm^3)

Volume of fruits from each plot was found from the selected fruits having mean weight using water displacement method.

3. 2.8.3 Weight of fruits (kg)

The mean weight of fruits per plant was measured in each treatment and recorded.

3. 2.8. 4 Yield per hectare

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

3. 2.9 Quality attributes

3. 2.9.1 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 shriveling and based on physical appearance.

3. 2.9.2 Organoleptic qualities

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 IV.

3. 2. 9.3 Appearance of fruit

Three fruits from each treatment were scored for colour, shape and size of fruits.

3. 2.10 Incidence of pests and diseases

The incidence of pests and diseases was observed and recorded.

3. 2.11B: C Ratio

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

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

3. 2. 12 Statistical analysis

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

Results

4. RESULTS

The results pertaining to the study on "Liquid formulations for production of organic oriental pickling melon (*Cucumis melo* var. *conomon* L.)" are furnished below.

4.1 Experiment I

Effect of seed treatment with liquid formulations on germination and seedling vigour in oriental pickling melon

4. 1. 1 Germination percentage

The germination percentage at 4 and 7 DAS is presented in Table 1. Early germination was observed in seeds treated with Panchagavyam, Cowdung slurry and Beejamrutham, among the eight treatments. The seeds in all treatments except T_2 (Cow urine) and T_8 (Control) germinated on third day after sowing. The seeds soaked in T_3 (Panchagavyam) recorded the highest germination of 70% on 4thday followed by T_1 (Cowdung slurry).T_7 (Beejamrutham + *Pseudomonas)* and T_8 (Control) had the minimum of 10 %.

On 7thday, the seeds treated with Panchagavyam (T_3) recorded the maximum germination (100%) but was on par with all other organic treatments. The seeds dipped in water alone recorded the lowest value of 83.33%. Seed treatment with different organic formulations enhanced the germination.

4. 1. 2 Time taken for emergence of radicle

No significant difference could be noticed among the treatments regarding the time taken for emergence of radicle (Table 2). All the treatments took 2 days for emergence of radicle, except the control which took 3 days.

4. 1. 3 Time taken for emergence of plumule

Time taken for emergence of plumule did not differ significantly among the treatments (Table 2). Except control (4 days) and cow urine (3 days) treated seeds, all other treatments took 2 days for emergence of plumule.

4. 1. 4 Length of radicle

There was significant difference among the treatments regarding the length of radicle at 7 DAS and 15 DAS.The length of radicle (Table 2) recorded at 7 DAS was the highest (2.76cm) in T_1(Cow dung slurry) and T_6 (Panchagavyam+ *Pseudomonas*). Minimum length was recorded in control plants (1.43cm). On 15^{th}day, T_6 (Panchagavyam) recorded the highest value (7.53 cm) followed by T_1 (Cow dung slurry) and T_2 (Cow urine) being 6.83cm. Minimum length of root (5.27cm) was recorded in control plants (Table 4).

4. 1. 5 Length of plumule

The length of plumule recorded at 7DAS was significantly superior inT_6 (Panchagavyam+ *Pseudomonas*) being 13.63cm but on par with T_7 (Beejamrutham+ Pseudomonas). The lowest value of 9.7cm was recorded in T_8 (Control) as provided in Table 2.The length of shoot recorded at 15DAS was the highest in T_6 (Panchagavyam+ *Pseudomonas*) being 19.07 cm followed by 18.50 cm inT_4 (Beejamrutham). The lowest value of 14.33 cm was recorded inT_8 (Control) as shown in Table 4.

4. 1. 6 Fresh weight

The whole plant fresh weight recorded at 7 DAS and 15 DAS showed significant difference among the treatments. At 7 DAS, the highest value of 300 mg was obtained in T_6 (Panchagavyam+ *Pseudomonas)* and the lowest of 116.66mg in control (Table 3). The same trend was observed at 15 DAS (Table 4). The highest

value was recorded in T_6 (Panchagavyam+ *Pseudomonas)* being 456.66mg but was on par with T_5 and T_7 (450.00 mg). The lowest value (216.66 mg) was observed in control plants.

4. 1. 7 Dry weight

The dry weight of the plants at 7 DAS is presented in Table 3. The treatment receiving T_6 (Panchagavyam+ *Pseudomonas)* recorded significantly higher value of 34.66 mg followed by T_5 (*Pseudomonas*) and T_4 (Beejamrutham) being 32.33 mg and 30.66 mg respectively. The control had the lowest value of 9.66 mg. The data of dry weight at 15 DAS (Table 4) revealed that T_6 (Panchagavyam+ *Pseudomonas)* had the highest value of 59.33 mg followed by T_5 (57.33 mg) and T_7 (56.00 mg). The lowest value of 20.33 mg was observed in control plants.

4. 1. 8Vigour index

At 7 DAS, the highest vigour index of 1581.33 was recorded in T_6 (Panchagavyam+ *Pseudomonas*) followed by T_7 and the lowest in control (T_8) being 794.66 (Table 3). The value (2567.28) was the highest in T_6 (Panchagavyam+ *Pseudomonas*) but on par with T1, T_3, T_4 and T_7 at 15 DAS. The control plants recorded the lowest vigour index of 1243.66 (Table 4).

Table1.Germination percentage at 4 and 7 DAS as influenced by the treatments

Treatments	Germination %	
	4 DAS	**7 DAS**
T_{1-} Cow dung slurry (1: 2)	66.66[a]	96.66 [a]
T_{2-} Cow urine (5%)	53.30[ab]	90.00 [a]
T_3- Panchagavyam (30%)	70.00[a]	100.00 [a]
T_4- Beejamrutham (100%)	53.00[ab]	93.33 [a]
T_5- *Pseudomonas* (5%)	43.33[bc]	93.33 [a]
T_6- (T_3 + T_5)	35.00[c]	96.66 [a]
T_{7-} (T_4 + T_5)	30.00[d]	93.33 [a]
T_{8-} Control (water alone)	10.00 [d]	83.33[b]
CD (0.05)	**18.69**	**10.60**

Table2. Radicle and plumule characters at 7 DAS as influenced by the treatments

Treatments	Time taken for radical emergence (Days)	Time taken for plumule emergence (Days)	Length of radicle (cm)	Length of plumule (cm)
T_{1-} Cow dung slurry (1: 2)	2	2	2.76^{a}	11.33^{bc}
T_{2-} Cow urine (5%)	2	3	2.43^{a}	11.20^{cd}
T_3- Panchagavyam (30%)	2	2	2.43^{a}	10.93^{cd}
T_4- Beejamrutham (100%)	2	2	2.56^{a}	11.83^{bc}
T_5- *Pseudomonas* (5%)	2	2	2.53^{a}	12.86^{ab}
T_6- $T_3 + T_5$	2	2	2.76^{a}	13.63^{a}
T_{7-} $T_4 + T_5$	2	2	2.26^{a}	13.56^{a}
T_{8-} Control (water alone)	3	4	1.43^{b}	9.70^{d}
CD (0.05)	**NS**	**NS**	**0.52**	**1.55**

Table3. Fresh weight, dry weight and vigour index of seedlings at 7 DAS as influenced by the treatments

Treatments	Fresh weight (mg)	Dry weight (mg)	Vigour index - I
T_{1}- Cow dung slurry (1: 2)	250.00^{ab}	26.33 ^{bc}	1365 ^{a}
T_{2}- Cow urine (5%)	216.66 ^{b}	21.66 ^{c}	1096 ^{b}
T_{3}- Panchagavyam (30%)	250.00 ^{ab}	27.00 ^{bc}	1336 ^{ab}
T_{4}- Beejamrutham (100%)	283.33^{ab}	30.66 ^{ab}	1345 ^{a}
T_{5}- *Pseudomonas* (5%)	273.33^{ab}	32.33 ^{ab}	1436 ^{a}
T_{6}- (T_{3} + T_{5})	300.00 ^{a}	34.66 ^{a}	1581 ^{a}
T_{7}- (T_{4} + T_{5})	250.00^{ab}	27.66^{abc}	1483 ^{a}
T_{8}- Control (water alone)	116.66 ^{c}	9.66 ^{d}	794 ^{c}
CD (0.05)	**81.03**	**7.60**	**247**

Table4.Seedling growth characters at 15 DAS as influenced by the treatments

Treatments	Length of root (cm)	Length of shoot (cm)	Fresh weight (mg)	Dry weight (mg)	Vigour index- I
T_1- Cow dung slurry (1: 2)	6.83^{ab}	17.00^{bcd}	350.00^{bc}	42.33^{cd}	2303^{a}
T_2- Cow urine (5%)	6.83^{ab}	15.66^{de}	316.66^{c}	34.33^{d}	2025^{b}
T_3- Panchagavyam (30%)	6.16^{bc}	16.83^{cd}	350.00^{bc}	44.33^{bcd}	2436^{a}
T_4- Beejamrutham (100%)	6.67^{b}	18.50^{a}	416.66^{ab}	52.66^{abc}	2352^{a}
T_5- *Pseudomonas* (5%)	5.53^{cd}	18.33^{ab}	450.00^{a}	57.33^{ab}	2229^{ab}
T_6- (T_3 + T_5)	7.53^{a}	19.07^{a}	456.66^{a}	59.33^{a}	2567^{a}
T_7- (T_4 + T_5)	5.53^{cd}	17.66^{abc}	450.00^{a}	56.00^{ab}	2290^{a}
T_8- Control (water alone)	5.27^{d}	14.33^{e}	216.66^{d}	20.33^{e}	1243^{c}
CD (0.05)	**0.79**	**1.43**	**97.02**	**13.39**	**268**

4. 2Experiment II

Evaluation of liquid organic manures on growth and yield of oriental pickling melon

4. 2. 1 GROWTH CHARACTERS

4. 2. 1.1 Germination percentage

The details of germination percentage at 7 DAS are presented in Table 5. It shows that there was no significant difference in germination percentage due to the treatments. All the treatments except POP (T9) were given the basal application of organic manures as per the package of practices recommendations (Adhoc) for organic farming: crops. The lowest germination percentage was observed in POP (80.50%). The seeds in all the treatments except POP (T9) were treated with (Panchagavyam+ *Pseudomonas)* which enhanced the germination and seedling vigour.

4. 2. 1. 2 Length of vines

The data presented in Table 6 shows the effect of different treatments on length of vines 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_{10} (Liquid extract of composite organic manures) recorded maximum vine length (9.75cm) which was on par with T_4 and T_5at 15 DAS. The POP (T_9) recorded the minimum length of vine (8.16 cm).

T_1 (Jeevamrutham) recorded the highest length of vine (65.91cm) at 30 DAS. The POP (T_9) recorded the minimum length of vine (50.00 cm). T_3 (Fish amino acid) recorded the maximum vine length of 114.16 cm at 45 DAS and the minimum of 84.08 cm was noticed in T_8 (Control without water spray).

4. 2. 1. 3 Number of leaves

Data furnished in Table 7 indicate the number of leaves recorded 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_{10} (Liquid extract of composite organic manure) recorded the highest number of leaves of 8.33 at 15 DAS followed by T_1 (Jeevamrutham) and T_5 (Green leaf extract). T_8 (Control without water spray) recorded the lowest number (5.33).

T_5 (Green leaf extract) recorded the maximum number of leaves (16.66) at 30DAS.

T_5 (Green leaf extract) and T_3 (Fish amino acid) showed the highest number of leaves (37.66) at45DAS while T_8 (Control without water spray) gave the minimum of 29.33.

Table 5. Germination percentage in the field at 7 DAS as influenced by the treatments

Treatments	7DAS (%)
T_1- Jeevamrutham	81.67
T_2- Panchagavyam	85.00
T_3 - Fish amino acid	88.33
T_4 - Cow urine	83.33
T_5- Green leaf extract	85.00
T_6 - (T_2 + T_3 + T_5)	83.33
T_7- Control (with water spray)	81.67
T_8 - Control (without water spray)	86.67
T_9 - POP (POP recommendations of KAU)	80.50
T_{10}- Liquid extract of composite organic manures	85.00
T_{11} - Commercial formulation (Biozyme)	81.67
CD (0.05)	**NS**

Table 6. Length of vine as influenced by the treatments

Treatments	Length of vine (cm)		
	15 DAS	**30 DAS**	**45 DAS**
T_1- Jeevamrutham	9.16^{ab}	65.91^{a}	110.83^{ab}
T_2- Panchagavyam	8.33^{b}	62.16^{abc}	110.00^{ab}
T_3 - Fish amino acid	9.16^{ab}	63.58^{ab}	114.16^{a}
T_4 - Cow urine	9.58^{a}	52.5^{ef}	89.53^{c}
T_5- Green leaf extract	9.25^{a}	59.83^{bcd}	106.25^{ab}
T_6 - (T_2 + T_3 + T_5)	9.25^{ab}	63.83^{ab}	105.83^{b}
T_7- Control (with water spray)	8.7^{ab}	52.91^{ef}	90.83^{c}
T_8 - Control (without water spray)	8.66^{ab}	50.58^{f}	84.08^{cd}
T_9 - POP (POP recommendations of KAU)	8.16^{b}	50.00^{f}	90.33^{d}
T_{10}- Liquid extract of composite organic manures	9.75^{a}	56.83^{cde}	107.91^{ab}
T_{11} - Commercial formulation (Biozyme)	9.16^{ab}	55.16^{def}	106.6^{ab}
CD (0.05)	**1.03**	**5.20**	**7.12**

Table 7. Number of leaves as influenced by the treatments

Treatments	Number of leaves		
	15 DAS	**30 DAS**	**45 DAS**
T_1- Jeevamrutham	8.00^{ab}	16.33^{ab}	37.33^{ab}
T_{2-} Panchagavyam	7.33^{bcd}	16.00^{ab}	36.00^{abc}
T_3 - Fish amino acid	7.00^{cde}	16.33^{ab}	37.66^{a}
T_4 - Cow urine	7.66^{abc}	14.66^{bcd}	31.66^{d}
T_5- Green leaf extract	8.00^{ab}	16.66^{a}	37.66^{a}
T_6 - (T_2 + T_3 + T_5)	6.33^{ef}	14.00^{cde}	35.33^{bc}
T_7- Control (with water spray)	6.00^{fg}	13.00^{de}	31.66^{d}
T_{8-} Control (without water spray)	5.33^{gh}	12.33^{e}	29.33^{e}
T_9 - POP (POP recommendations of KAU)	5.66^{gh}	12.00^{e}	30.66^{e}
T_{10}- Liquid extract of composite organic manures	8.33^{a}	16.00^{ab}	35.33^{bc}
T_{11} - Commercial formulation (Biozyme)	6.66^{def}	15.00^{abc}	34.00^{c}
CD (0.05)	**0.84**	**1.94**	**2.11**

4. 2. 1. 4 Days to first flower opening

Days taken for first flower opening varied significantly among the treatments (Table 8).The treatments receiving Jeevamrutham (T_1) and Fish amino acid (T_3) flowered earlier (22.66 DAS) followed by T_5 and T_2.The flowering was delayed by 3-5 days in all other treatments. The plants in the treatment receiving T_9 (POP) were the last to flower (31 DAS).

4. 2. 1. 5 Days to first harvest

Days taken for first harvest furnished Table 8 shows that there was significant difference among the treatments. T_5 (Green leaf extract) recorded early harvesting (50.33 DAS) which was on the par with T_3 (Panchagavyam) andT_1 (Jeevamrutham) while T_9 (POP) took maximum days of 62.66 days to harvest.

4. 2. 1. 6Dry matter production

The data on dry matter production of the crop is furnished in Table9. Among the treatments, T_1 (Jeevamrutham) recorded the highest DMP of 96.4 g plant^{-1}followed by T_5 (Green leaf extract). T_9 (POP) recorded the lowest DMP (60.33 g plant^{-1}).

4. 2. 1. 7 Number of harvests

There was no significant difference in the number of harvests among the treatments (Table 9). Harvesting could be done 3 times in all the treatments except in T_9 (POP) being twice.

4. 2. 1. 8 Duration of the crop

The data on duration of the crop are furnished in Table 9. It shows that there was significant difference among the treatments. T_5 (Green leaf extract) recorded the highest duration (80 days) followed by T_{10} (Liquid extract of composit organic

manure) and T_3 (Fish amino acid). The lowest crop duration was noticed in T_9 (POP) being 66.33 days.

Table 8. Days to first flower opening and first harvest as influenced by the treatments

Treatments	Days to first flower opening	Days to first harvest
T_1- Jeevamrutham	22.66^{e}	51.00^{e}
T_2- Panchagavyam	23.66^{e}	53.33^{d}
T_3 - Fish amino acid	22.66^{e}	50.66^{e}
T_4 - Cow urine	27.33^{bc}	58.00^{b}
T_5- Green leaf extract	23.33^{e}	50.33^{e}
T_6 - (T_2 + T_3 + T_5)	25.33^{d}	55.00^{c}
T_7- Control (with water spray)	26.33^{cd}	54.66 ^{cd}
T_8 - Control (without water spray)	28.66^{b}	58.00^{b}
T_9 - POP (POP recommendations of KAU)	31.00^{a}	62.66^{a}
T_{10}- Liquid extract of composite organic manures	25.33^{d}	51.33 ^{e}
T_{11} - Commercial formulation (Biozyme)	28.66^{b}	53.33 ^{d}
CD (0.05)	**1.33**	**1.38**

Table9. Drymatter production, number of harvests and duration of the crop as influenced by the treatments

Treatments	Dry matter Production at harvest (g/plant)	Number of harvests	Duration the crop (days)
T_1- Jeevamrutham	96.4^{a}	3	75.66^{abc}
T_{2-} Panchagavyam	87.2^{bc}	3	74.00^{bc}
T_3 - Fish amino acid	84.7^{cd}	3	76.33^{ab}
T_4 - Cow urine	80.06^{de}	3	68.00^{de}
T_5- Green leaf extract	90.13^{b}	3	80.00^{a}
T_6 - (T_2 + T_3 + T_5)	80.16^{de}	3	74.66^{bc}
T_7- Control (with water spray)	71.73^{f}	3	68.00^{de}
T_{8-} Control (without water spray)	67.73^{f}	3	67.00^{de}
T_9 - POP (POP recommendations of KAU)	60.33^{f}	2	66.33^{e}
T_{10}- Liquid extract of composite organic manures	83.80^{cd}	3	77.66^{ab}
T_{11} - Commercial formulation (Biozyme)	78.16^{e}	3	71.33^{cd}
CD (0.05)	**5. 26**	**NS**	**4.79**

4. 2. 2 PHYSIOLOGICAL CHARACTERS

4. 2. 2.1 Chlorophyll content

Chlorophyll content (a, b and total) presented in Table 10 reveals that there is significant variation among the treatments. Chlorophyll a content was the highest in T_1 (Jeevamrutham) being 0.57 mg g^{-1} at 15 DAS, 0.81 mg g^{-1} in T_{10} (Liquid extract of composite organic manure) at 30 DAS and 1.32 mg g^{-1} in T_5 (Green leaf extract) at 45 DAS.

Chlorophyll b was the highest in T_5 (Green leaf extract) being 0.33 mg g^{-1}at 15 DAS, 0.31 mg g^{-1} in T_3 (Fish amino acid) at 30 DAS and0.45 mg g^{-1} inT_1 (Jeevamrutham) at 45 DAS.

Highest total Chlorophyll content of 0.77 mg g^{-1} was noticed in T_5 (Green leaf extract) at 15 DAS.T_{10} (Liquid extract of composite organic manure) had the highest value of 1.09 mg g^{-1} at 30 DAS.T_5 (Green leaf extract) showed the highest value of 1.62 mg g^{-1} at 45 DAS.

The lowest value of chlorophyll content (Chlorophyll a, Chlorophyll b and Total Chlorophyll at all stages of the crop) was recorded in T_9 (POP).The treatments receiving liquid formulations resulted in higher chlorophyll content compared to T_9 (POP).

4. 2. 3 YIELD AND YIELD ATTRIBUTES

4. 2. 3.1 Number of fruits per plant

The data on number of fruits per plant are presented in Table 11. It shows that there was significant difference in the number of fruits among the treatments.T_1 (Jeevamrutham) recorded the highest number of fruits (3.83) followed by T_2

Panchagavyam (3.73). The lowest number of fruits (2.24) was recorded in T_8 (Control without water spray).

4. 2. 3. 2 Volume of fruits

The data on volume of fruits (cm^3) is furnished in Table 11. It shows that there was significant difference in the volume of fruits among the treatments.T_1 (Jeevamrutham) recorded the highest volume of fruits (770. 00 cm^3) followed by fish amino acid (755.00 cm^3). The lowest volume of fruits (553.33 cm^3) was recorded in T_8 (Control without water spray).

4. 2. 3. 3 Weight of fruits

The data on weight of fruits is furnished in Table 11. It shows that there was significant difference in the weight of fruits among the treatments.T_1 (Jeevamrutham) recorded the highest weight of fruits (2.5 kg $plant^{-1}$) followed by T_2 Panchagavyam (2.43 kg $plant^{-1}$). The lowest fruit weight (1.46 kg $plant^{-1}$) was noticed in T_8 (Control without water spray).

4. 2. 3. 4 Yield

The data on yield furnished in Table 11 reveals that there was significant difference in the yield among the treatments.T_1 (Jeevamrutham) recorded the highest yield of 30.33 t ha^{-1} followed by T_2 (Panchagavyam) with 29.50 t ha^{-1}. The lowest yield of 17.83 t ha^{-1} was observed in T_8 (Control without water spray).

Table 10. Chlorophyll content (mg/g) as influenced by the treatments

Treatments	Chlorophyll a			Chlorophyll b			Total Chlorophyll		
	15DAS	30DAS	45DAS	15DAS	30DAS	45DAS	15DAS	30DAS	45DAS
T_1 - Jeevamrutham	0.57^{a}	0.76^{abc}	1.15^{b}	0.16^{i}	0.25^{d}	0.45^{a}	0.74^{b}	1.01^{e}	1.60^{a}
T_2 - Panchagavyam	0.41^{bc}	0.77^{ab}	1.27^{a}	0.25^{ef}	0.27^{c}	0.28^{b}	0.67^{d}	1.05^{c}	1.56^{ab}
T_3 - Fish amino acid	0.38^{c}	0.73^{bc}	1.17^{b}	0.21^{h}	0.31^{a}	0.27^{b}	0.59^{f}	1.04^{d}	1.45^{abc}
T_4 - Cow urine	0.18^{e}	0.73^{bc}	1.04^{d}	0.28^{c}	0.23^{e}	0.29^{b}	0.46^{j}	0.96^{g}	1.30^{c}
T_5 - Green leaf extract	0.43^{bc}	0.77^{ab}	1.32^{a}	0.33^{a}	0.28^{b}	0.29^{b}	0.77^{a}	1.06^{b}	1.62^{a}
T_6 - (T_2 + T_3 + T_5)	0.39^{c}	0.70^{cd}	1.03^{d}	0.25^{e}	0.21^{gh}	0.26^{b}	0.65^{e}	0.92^{h}	1.29^{c}
T_7 - Control (with water spray)	0.24^{d}	0.75^{bc}	1.18^{b}	0.25^{fg}	0.22^{f}	0.29^{b}	0.49^{h}	0.98^{f}	1.47^{abc}
T_8 - Control (without water spray)	0.23^{de}	0.66^{d}	0.97^{e}	0.24^{g}	0.22^{fg}	0.34^{ab}	0.48^{i}	0.89^{i}	1.32^{c}
T_9 - POP (KAU)	0.17^{e}	0.57^{e}	0.77^{f}	0.12^{j}	0.20^{i}	0.27^{b}	0.29^{k}	0.77^{j}	1.04^{d}
T_{10} - Liquid extract of composite organic manure	0.45^{b}	0.81^{a}	1.21^{b}	0.26^{d}	0.27^{c}	0.37^{ab}	0.72^{c}	1.09^{a}	1.58^{a}
T_{11} - Commercial formulation (Biozyme)	0.24^{d}	0.71^{cd}	1.10^{c}	0.26^{d}	0.21^{h}	0.29^{b}	0.51^{g}	0.92^{h}	1.39^{bc}
CD (0.05)	**0.053**	**0.053**	**0.053**	**0.005**	**0.005**	**0.12**	**0.005**	**0.005**	**0.17**

Table 11. Number of fruits, volume of fruits, weight of fruits and yield as influenced By the treatments

Treatments	No of fruits per plant	Volume of fruits (cm^3)	Weight of Fruits (kg/plant)	Yield (t/ ha)
T_1- Jeevamrutham	3.83 [a]	770.00 [a]	2.5 [a]	30.33 [a]
T_2- Panchagavyam	3.73 [a]	751.66 [b]	2.43 [a]	29.50 [a]
T_3 - Fish amino acid	3.39 [a]	755.00 [ab]	2.21 [ab]	27.13 [a]
T_4 - Cow urine	2.93 [b]	750.00 [b]	1.91 [bc]	23.00 [b]
T_5- Green leaf extract	3.47 [a]	753.33 [ab]	2.26 [a]	27.5 [a]
T_6 - (T_2 + T_3 + T_5)	2.88 [b]	673.33 [d]	1.88 [c]	22.83 [b]
T_7- Control (with water spray)	2.29 [c]	586.66 [e]	1.50 [d]	18.33 [c]
T_8 - Control (without water spray)	2.24 [c]	553.33 [f]	1.46 [d]	17.83 [c]
T_9 - POP (POP recommendations of KAU)	2.66 [bc]	593.33 [e]	1.68 [cd]	20.50 [bc]
T_{10}- Liquid extract of composite organic manures	3.62 [a]	750.00 [b]	2.36 [a]	28.66 [a]
T_{11} - Commercial formulation (Biozyme)	2.68 [bc]	716.66 [c]	1.75 [cd]	21.66 [bc]
CD (0.05)	**0.45**	**18.30**	**0.30**	**3.56**

4. 2. 4 QUALITY ATTRIBUTES

4. 2. 4.1 Shelf life of the fruit

The data on the shelf life of the fruits are furnished in Table 12. It is seen that there was significant difference in the shelf life of fruits among the treatments.

T_3 (Fish amino acid) recorded the maximum shelf life of 19.66 days followed by 19.33 days in T_2 (Panchagavyam) and T_5 (Green leaf extract).The minimum shelf life (10.66 days) was observed in T_9 (POP). All the organic liquid formulation treatments recorded higher shelf life compared to T_9 (POP).

4. 2. 4. 2 Organoleptic test

The data pertaining to organoleptic test is provided in Table 13. 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 (8.17) had been recorded in T_3 (Fish amino acid) followed by T_1 (Jeevamrutham) and T_5 (Green leaf extract) being 7.75. The highest score for colour (8.25) was obtained in T_3 (Fish amino acid) followed by T_1 (Jeevamrutham). The highest score (7.92) for flavour could be noticed in T_3 (Fish amino acid) followed by T_1 (Jeevamrutham).T_3 (Fish amino acid) showed the highest score in texture and odour, the values being 6.92 and 7.25 respectively. The scores for the taste and after taste obtained was the highest in T_3 (Fish amino acid) being 8.25 and 7.75. The rating for overall acceptability was the highest forT_3 (Fish amino acid) followed by T_1 (Jeevamrutham) and T_2 (Panchagavyam). The treatment receiving T_9 (POP) had the lowest values for all the organoleptic qualities.

Table 12. Shelf life of the fruits as influenced by the treatments

Treatments	Shelf life of the fruit (days)
T_1- Jeevamrutham	18.33[b]
T_2- Panchagavyam	19.33[a]
T_3 - Fish amino acid	19.66[a]
T_4 - Cow urine	17.66 [bc]
T_5- Green leaf extract	19.33 [a]
T_6 - (T_2 + T_3 + T_5)	18. 33[b]
T_7- Control (with water spray)	17. 66 [bc]
T_8 - Control (without water spray)	17. 00[c]
T_9 - POP (POP recommendations of KAU)	10. 66[d]
T_{10}- Liquid extract of composite organic manures	18. 33[b]
T_{11} - Commercial formulation (Biozyme)	15 33[c]
CD (0.05)	**1.27**

Table 13.Organoleptic qualities of the fruits (Score) as influenced by the treatments

Treatments	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability
T_1Jeevamrutham	7.75	7.92	7.75	6.75	7.17	7.42	7.33	7.5
T_2 Panchagavyam	7.33	7.17	7.08	6.25	7.00	7.50	7.17	7.5
T_3 Fish amino acid	8.17	8.25	7.92	6.92	7.25	8.25	7.75	8.25
T_4 Cow urine	6.50	6.50	6.33	5.67	6.17	6.67	6.25	6.42
T_5 Green leaf extract	7.75	7.67	7.67	7.08	7.17	7.42	7.33	7.42
T_6 (T_2 + T3 + T5)	7.75	7.17	6.92	6.00	6.42	7.00	6.75	6.75
T_7 Control (with water spray)	5.75	5.58	5.92	5.17	5.58	5.67	5.67	5.33
T_8 Control (without water spray)	5.67	5.58	5.75	5.17	5.00	5.75	6.67	5.5
T9 POP	3.50	3.00	2.67	2.92	3.08	3.08	3.00	3.5
T_{10} Liquid extract of composite organic manure	6.50	6.42	6.58	6.25	6.67	6.08	6.25	6.25
T_{11} Commercial formulation (Biozyme)	7.08	6.92	6.58	6.25	6.75	6.75	6.67	6.92
Kendall's W(a)	**0. 45**	**0.69**	**0.75**	**0.80**	**0.83**	**0.80**	**0.82**	**0.81**

4.2.5 Incidence of pests and diseases

No severe attack of pests and diseases was observed in experimental plots. However, the attack of pumpkin beetle, fruit fly, aphids and termites was noticed in T_9 (POP), T_7 (Control with water spray) and T_8 (Control without water spray). Beauveria, Neemsoap, Verticillium and garlic + chilli extract were sprayed for controlling the pests, and the termites were controlled by *Metarrhizium.*

4. 2 .6 SOIL ANALYSIS

4.2.6.1 pH

The pH of the soil before and after the experiment is furnished in Table14. The initial pH of the soil was 5.03. The treatment receiving Fish amino acid (T_3) recorded the highest pH (6.21) after the experiment, followed by T_1 (Jeevamrutham) with a pH of 5.97.

4. 2. 6. 2 EC

The EC of the soil before and after the experiment presented in Table 14 revealed the significant differences among the treatments. The initial EC of the soil was (0.075 dS m^{-1}). After the experiment, the treatment receiving T_8 Control (without water spray) and T_9 (POP)recorded the highest EC (0.56 dS m^{-1}) followed by T_{10} (Liquid extract of composite organic manure). The lowest value was observed in the treatment receiving Panchagavyam (0.24 dS m^{-1})

4. 2. 6. 3 Organic carbon content

The organic carbon content of the soil before and after the experiment is furnished in Table 15. It shows that there was significant difference in the soil organic carbon content. The initial content of organic carbon of the soil was 1. 22 %. After the experiment the treatment receiving T_5 (Green leaf extract) recorded the

highest organic carbon content (1.58%) followed by T_1 (Jeevamrutham) with1.56%. The lowest value of 1.23% was noticed in T_9 (POP).

4.2.6.4 Available Nitrogen

The available nitrogen content of the soil before and after the experiment (Table 15) revealed that the treatments had significant difference on soil available nitrogen. The highest content of available nitrogen was recorded in T1 (Jeevamrutham) with a value of 489 kg/ha followed by 472.7 kg/ha inT_5 (Green leaf extract).The lowest content (389.9 kg/ha) was recorded in T_9 (POP).The initial value was 313.5 kg/ha.

4. 2. 6. 5 Available Phosphorus

The data given in (Table 15) clearly shows the significant influence of treatments on available phosphorus content in soil. T_{10} (Liquid extract of composite organic manure) recorded the maximum P content 25.42kg/ha, followed by Green leaf extract (24.99 kg/ha).The lowest content of P was recorded inT_9 (POP) being 18.19 kg/ha. Initial value of P content in soil was 15.17 kg/ha.

4. 2. 6. 6 Available Potassium

The treatments significantly influenced the available potassium content of soil after the experiment (Table 15).T_5 (Green leaf extract) recorded the highest potassium content of 309.49kg/ha followed by T_1 (Jeevamrutham) with a value of 305.76 kg/ha. The lowest content of K was recorded inT_9 (POP) being 251.62 kg/ha. Initial K content of the soil was 232.76 kg/ha.

Table 14.Soil pH and EC as influenced by the treatments

Treatments	pH	EC (dS m^{-1})
T_1- Jeevamrutham	5.97^{abc}	0.03^{e}
T_2- Panchagavyam	5.85^{abc}	0.02^{g}
T_3 - Fish amino acid	6.21^{a}	0.02^{fg}
T_4 - Cow urine	5.39^{de}	0.04^{d}
T_5- Green leaf extract	5.81^{bc}	0.03^{ef}
T_6 - (T_2 + T_3 + T_5)	5.75^{bcd}	0.03^{e}
T_7- Control (with water spray)	5.25^{cd}	0.04^{c}
T_8 - Control (without water spray)	5.65^{cd}	0.056^{a}
T_9 - POP (POP recommendations of KAU)	5.06^{e}	0.05^{ab}
T_{10}- Liquid extract of composite organic manures	5.74^{bcd}	0.05^{bc}
T_{11} - Commercial formulation (Biozyme)	5.65^{cd}	0.04^{cd}
CD (0.05)	**0.36**	**0.05**
Initial value	**5.03**	**0.07**

Table 15.Organic carbon, available nitrogen, phosphorus and potassium content of soil as influenced by the treatments

Treatments	Organic carbon (%)	Nitrogen (kg/ha)	Phosphorous (kg/ha)	Potassium (kg/ha)
T_1- Jeevamrutham	1.56^{ab}	489.0^{a}	24.3^{abc}	305.76^{a}
T_2- Panchagavyam	1.35^{cde}	460.2^{bc}	22.94^{cd}	302.02^{abc}
T_3 - Fish amino acid	1.45^{bc}	447.7^{cd}	23.38^{bcd}	293.06^{cd}
T_4 - Cow urine	1.26^{e}	426.3^{e}	20.97^{e}	281.8^{de}
T_5- Green leaf extract	1.58^{a}	472.7^{ab}	24.99^{ab}	309.49^{a}
T_6 - (T_2 + T_3 + T_5)	1.41^{c}	447.8^{cd}	22.94^{cd}	285.97^{de}
T_7- Control (with water spray)	1.45^{bc}	434.7^{de}	22.36^{de}	285.6^{de}
T_8 - Control (without water spray)	1.43^{c}	429.0^{f}	20.75^{e}	278.13^{e}
T_9 - POP (POP recommendations of KAU)	1.23^{f}	389.9^{g}	18.19^{f}	251.62^{f}
T_{10}- Liquid extract of composite organic manures	1.38^{cd}	447.3^{cd}	25.42^{a}	302.77^{abc}
T_{11} - Commercial formulation (Biozyme)	1.28^{de}	435.0^{de}	22.58^{cde}	293.81^{bcd}
CD (0.05)	**0.11**	**16.40**	**1.87**	**12.27**
Initial value	**1.22**	**313.5**	**15.17**	

4.2.7 MICROBIAL POPULATION IN SOIL

The data on microbial population in soil are furnished in Table 16. It showed that there was significant difference in the microbial count among the treatments at all the stages of growth of plants.

The highest population of bacteria (32.33 $x10^6$cfu g^{-1}) was noticed in T_1 (Jeevamrutham) and T_2 (Panchagavyam) whereas the lowest of 18.66 $x10^6$ cfu g^{-1} was found in T_9 (POP) at 15 DAS. At 30 DAS, the highest population of bacteria (70.66 $x10^6$ cfu g^{-1}) was observed in T_1 (Jeevamrutham) and the lowest of 27.33 $x10^6$cfu g^{-1} in T_9 (POP).

The highest population of fungi (26.00$x10^4$ cfu g^{-1}) was observed inT_2 (Panchagavyam) followed by T_1 (Jeevamrutham) at 15 DAS. At 30 DAS, the highest fungal count of 57.00 x 10^4cfu $g^{-1}$was noticed in T_{10} (Liquid extract of composite organic manures) followed by T_6 (Panchagavyam+ FAA + Green leaf extract). The lowest value of 18.66 cfu g^{-1} was recorded in T_9 (POP).

The highest population of actinomycetes (13.33 $x10^5$cfu g^{-1}) was noticed in T_1 (Jeevamrutham) and that in T9 (POP) was 9.33 $x10^5$cfu g^{-1}at 15 DAS. At 30 DAS, the highest population of actinomycetes (38.66 $x10^5$cfu g^{-1}) could be found in T_1 (Jeevamrutham) whereas the lowest population of 13.00$x10^5$cfu $g^{-1}$was in T_9 (POP).

The initial population of fungi, bacteria and actinomycetes were 10 $x10^4$cfu g^{-1},16$x10^6$ cfu g^{-1} and 8 $x10^5$ cfu g^{-1}, respectively. Application of organic manures and liquid formulations has enhanced the microbial activity of the soil than the POP.

4. 2. 8 Characteristics of liquid formulations

The characteristics of liquid formulations are presented in Table 17.

4. 2. 8. 1 pH

The pH of Panchagavyam and Fish amino acid was found to be acidic (4.25 and 4.55 respectively), while Jeevamrutham, Green leaf extract and Composite organic manure were near neutral (6.25, 6.24 and 6.50 respectively). Cow urine had a pH of 7.91, which was alkaline.

4. 2. 8. 2 EC

The EC of the liquid formulations is furnished in Table 17. The highest value of EC was recorded for Jeevamrutham (7.28 dS m^{-1}) followed by cow urine (7.24 dS m^{-1}). The lowest value of 1.49 dS m^{-1} was noticed in green leaf extract.

4.2.8.3 Nitrogen content

Estimation of the nitrogen content in the liquid formulations revealed that it is the highest in Composite organic manure (6.2%) followed by Fish amino acid (5.2%). The lowest value was recorded in Jeevamrutham (0.5%) as given in Table 17.

4.2.8.4 Phosphorus content

The highest phosphorus content was (Table 17) observed in fish amino acid (2.5%) followed by Composite organic manure (1.6%). The lowest value was recorded in green leaf extract (0.2%).

4.2.8.5 Potassium content

The highest potassium content was found in Composite organic manure (1.4%) followed by Fish amino acid (1.30%). The lowest value was recorded in Green leaf extract (0.25%).

4.2.9 MICROBIAL POPULATION IN LIQUID FORMULATIONS

The data on microbial population in liquid formulations are furnished in Table18. It showed that there was significant difference in the total microbial count of the liquid formulations. The fungal count was the highest in Panchagavyam ($43.33x10^4$cfu /g) followed by Jeevamrutham ($42.33x10^4$ cfu /g). The lowest fungal population was recorded in composite organic manure ($22.66x10^4$cfu /g).

The bacterial population was highest in Panchagavyam ($87.66\ x10^5$cfu /g) followed by Fish amino acid ($82.33x10^5$cfu /g). The lowest bacterial count was noticed in Green leaf extract ($57.66x10^5$cfu /g).

Table 16.Total microbial population in soil as influenced by the treatments

Treatments	Bacterial count (X 10^6 cfu /g)		Fungal count (X 10^4 cfu /g)		Actinomycetes count (X 10^5 cfu /g)	
	15 DAS	30 DAS	15 DAS	30 DAS	15 DAS	30 DAS
T_1-Jeevamrutham	32.33^{a}	70.66^{a}	24.00^{ab}	45.00^{cd}	13.33^{a}	38.66^{a}
T_2 -Panchagavyam	32.33^{a}	69.00^{a}	26.00^{a}	51.66^{ab}	11.66^{abc}	30.66^{bc}
T_3 - Fish amino acid	30.33^{a}	62.00^{bc}	21.00^{c}	49.00^{bc}	11.33^{bc}	32.33^{abc}
T_4 - Cow urine	22.66^{c}	39.66^{cd}	21.33^{c}	35.33^{cde}	10.66^{bcd}	24.00^{cde}
T_5 - Green leaf extract	30.33^{a}	65.00^{ab}	19.66^{c}	51.66^{ab}	12.33^{ab}	38.66^{a}
T_6 - (T_2 + T3 + T5)	30.33^{a}	50.33^{de}	21.33^{c}	55.00^{ab}	11.33^{bc}	29.33^{bcd}
T_7 - Control (with water spray)	20.77^{cd}	44.66^{ef}	17.00^{d}	37.66^{ef}	11.33^{bc}	22.00^{de}
T_8- Control (without water spray)	18.66^{de}	41.00^{f}	15.66^{d}	40.00^{def}	10.66^{bcd}	21.00^{e}
T_9 - POP	16.66^{e}	27.33^{g}	15.66^{d}	18.66^{g}	9.33^{d}	13.00^{f}
T_{10} -Liquid extract of composite organic manure	30.00^{a}	70.00^{a}	23.66^{b}	57.00^{a}	10.66^{bcd}	35.00^{ab}
T_{11} - Commercial formulation (Biozyme)	26.66^{b}	48.00^{e}	20.66^{c}	36.66^{f}	10.33^{cd}	29.33^{bcd}
CD (0.05)	**3.28**	**5.83**	**2.302**	**6.063**	**1.81**	**8.32**
Initial value	**16**	**16**	**10**	**10**	**8**	**8**

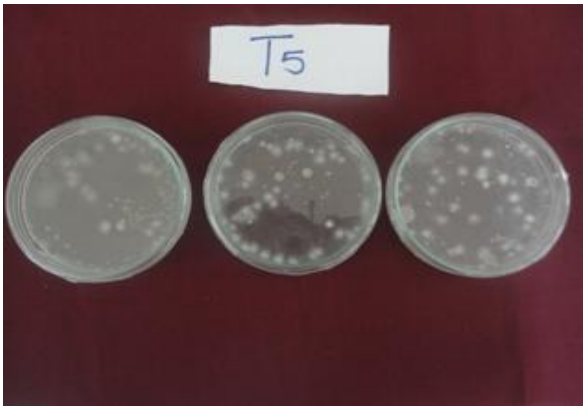
Table 17. Characteristics of liquid formulations

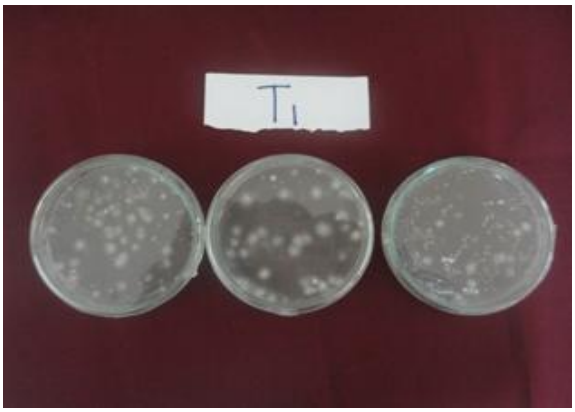
Treatments	pH	EC(dS m^{-1})	Nitrogen (%)	Phospho-rus (%)	Potassium (%)
Jeevamrutham	6.25	7.28	0.50	0.30	0.42
Panchagavyam	4.25	4.33	0.75	0.55	0.60
Fish amino acid	4.55	1.59	5.20	2.50	1.30
Cow urine	7.91	7.24	1.20	0.50	1.00
Green leaf extract	6.24	1.49	0.55	0.20	0.25
Composite organic manure	6.50	3.50	6.20	1.60	1.40

Table 18. Total microbial population in liquid formulations

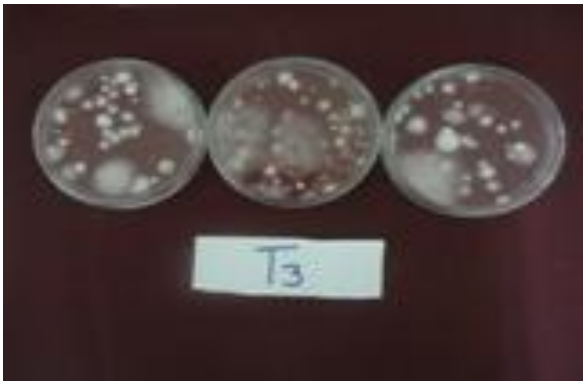
Liquid formulation	Fungal count (X 10^{3} cfu /g)	Bacterial count (X 10^{5} cfu /g)
Jeevamrutham	42.33^{ab}	81.66^{b}
Panchagavyam	43.33^{a}	87.66^{a}
Fish amino acid	38.66^{b}	82.33^{b}
Green leaf extract	27.66^{c}	57.66^{c}
Composite organic manure	22.66^{d}	62.33^{c}
CD (0.05)	**4.35**	**4.72**

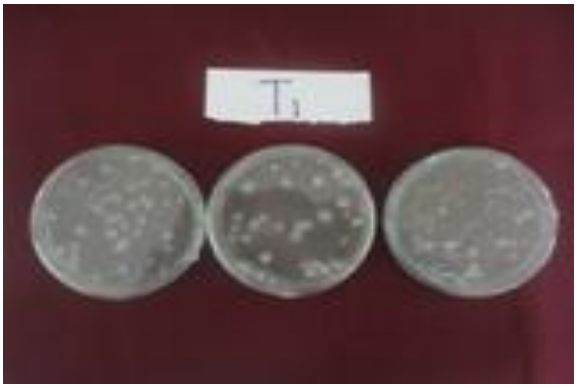
Plate 7. Total microbial populations in the soil



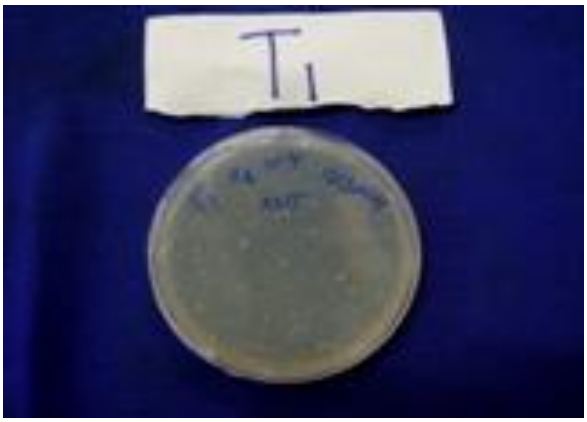


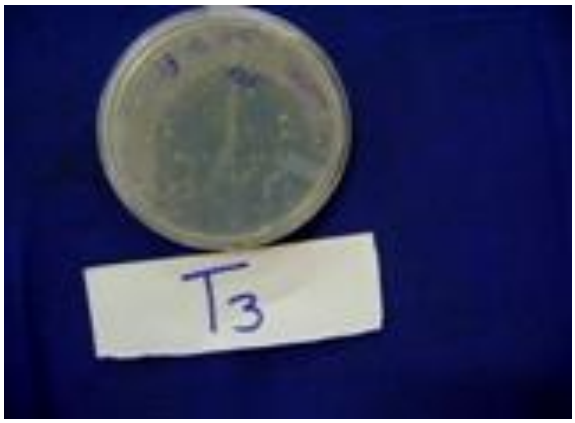
Bacterial colony formation at 30 DAS





Fungal colony formation at 30 DAS





Actinomycetes colony formation at 30 DAS

4.2. 10 ECONOMIC ANALYSES

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_1 (Jeevamrutham) was found to be significantly superior to other treatments with regard to gross return, net return and B: C ratio followed by T_5 (Green leaf extract). T_1 (Jeevamrutham) achieved a B: C ratio of 2.09 while the present package of practices recommendation recorded the B:C ratio of only 1.77. The lowest net income (Rs.1, 08, 250 ha $^{-1}$) and B: C ratio (1.32) was registered in T_8 (Control without water spray).

Table19. Total cost of cultivation, gross return, net return and B: C ratio as influenced the by treatments

Treatments	Total cost of cultivation(Rs	Gross return(Rs)	Net return (Rs)	B: C ratio
T_1 - Jeevamrutham	3,62,500	7,58,250	3,95,750	2.09
T_2- Panchagavyam	3,79,166	7,37,500	3,58,334	1.94
T_3- Fish amino acid	3,51,388	6,78,250	3,26,862	1.93
T_4 - Cow urine	3,44,444	5,75,000	2,30,556	1.66
T_5 - Green leaf extract	3,40,277	6,87,500	3,47,223	2.02
T_6 - (T_2 + T_3 + T_5)	3,55,555	5,70,750	2,15,195	1.60
T_7 - Control (with water spray)	3,37,500	4,58,250	1,20,750	1.35
T_8 - Control (without water spray)	3,37,500	4,45,750	1,08,250	1.32
T_9 - POP	2,88,888	5,12,500	2,23,612	1.77
T_{10} - Liquid extract of composite organic manure	4,25,000	7,16,500	2,91,500	1.68
T_{11} - Commercial formulation (Biozyme)	4,04,166	5,41,500	1,37,334	1.33

Discussion

5. DISCUSSION

The experiment entitled "Liquid formulations for production of organic oriental pickling melon (*Cucumis melo* var. *conomon* L.)" was conducted during 2013-2014 in College of Horticulture, Vellanikkara. The results pertaining to the study have been discussed below.

5.1 Experiment I

Effect of seed treatment with liquid formulations on germination and seedling vigour in oriental pickling melon

5.1.1. Germination percentage and seedling characters as influenced by seed treatment

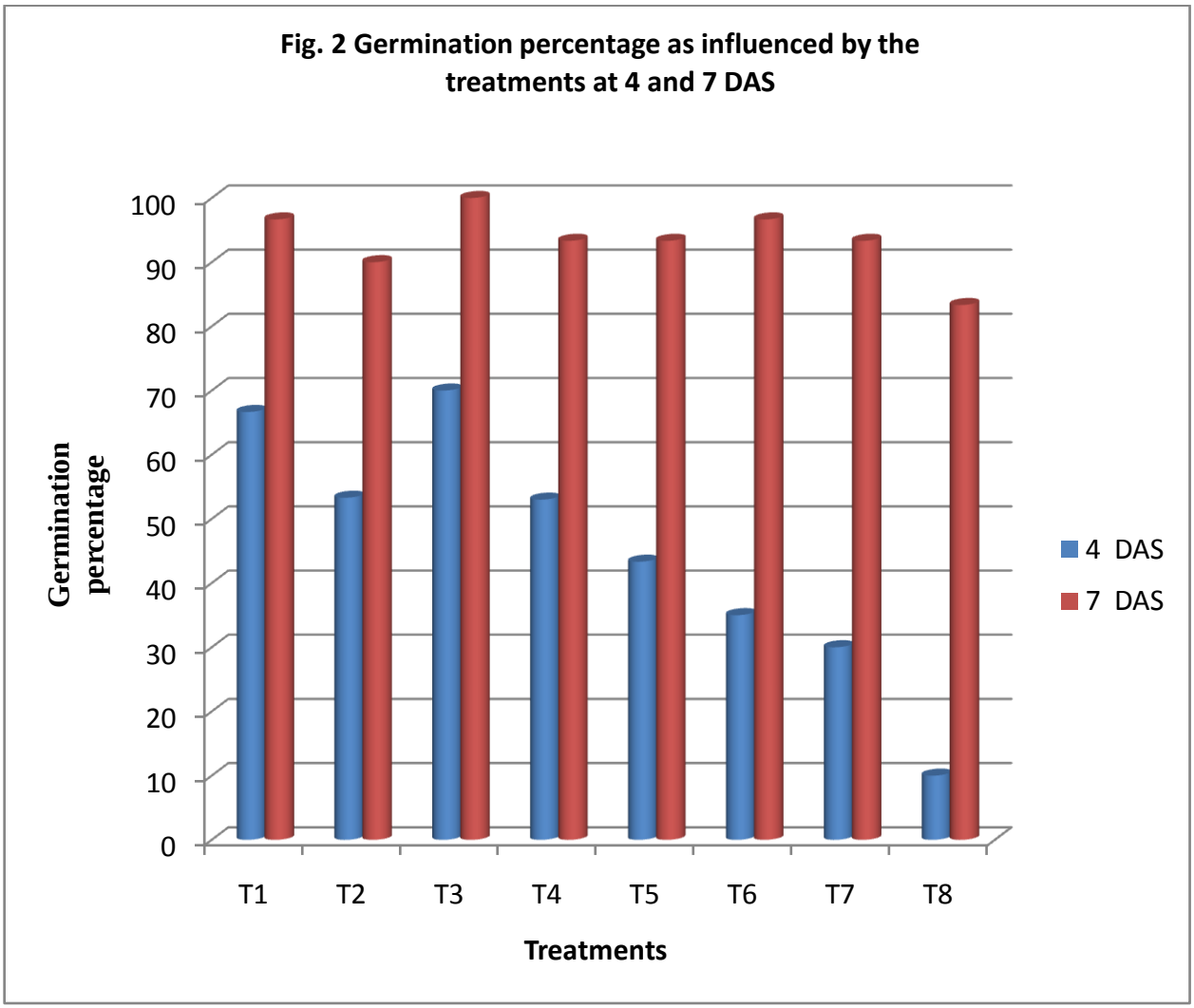
The treatments receiving Panchagavyam+ *Pseudomonas* recorded early germination and the highest germination percentage followed by Cow dung slurry and Beejamrutham as depicted in Fig.2. Panchagavyam, Cowdung slurry and Beejamrutham contains several hormones which enhanced the germination of seeds. The same trend was observed by Palekar (2007) and Sreenivasa *et al. (*2011).

All the treatments took 2 days for emergence of radicle except the control which took 3 days. The treatments except the control (4 days) and cow urine (3 days) treated seeds took 2 days for emergence of plumule. The length of root recorded 7 DAS was highest in T_1 (Cowdung slurry). The same trend was noticed by Gore (2009) where combined application of Beejamrutham, Jeevamrutham and Panchagavya at 75 and 160 days after sowing of tomato increased the enzymatic activities, plant growth, root length and N, P and K concentration.

5. 1. 2. Seedling characters

At 7DAS, the highest value of fresh weight of 300 mg was obtained in T_6 (Panchagavyam+ *Pseudomonas*). The same trend was observed at15 DAS. The dry weight was also the highest in the treatment receiving T_6 (Panchagavyam+

Fig. 2 Germination percentage as influenced by the treatments at 4 and 7 DAS



T1. Cowdung slurry (1: 2)
(1part cow dung: 2 parts water)

T2. Cow urine (5%)

T3. Panchagavyam (30%)

T4. Beejamrutham (100%)

T5. *Pseudomonas* (5%)

T6. T3 + T5

T7. T4 + T5

T8. Control

Pseudomonas) at 7DAS and15 DAS. Chandrakala (2008) also observed that the combined application of liquid manures like Beejamrutham and Panchagavyam significantly enhanced the growth in chilli seedlings.

At 7DAS and 15 DAS, the highest vigour index was recorded inT_6 (Panchagavyam+ *Pseudomonas)* as depicted in Fig.3.The results agree with the findings of Pillai (2012) in amaranth and okra and Krishnan (2014) in salad cucumber.

It is very clear that seed treatment with liquid formulations have improved the seed germination and seedling vigour due to the growth promoting substances and micro organisms present in the liquid formulations.

5. 2. Experiment II

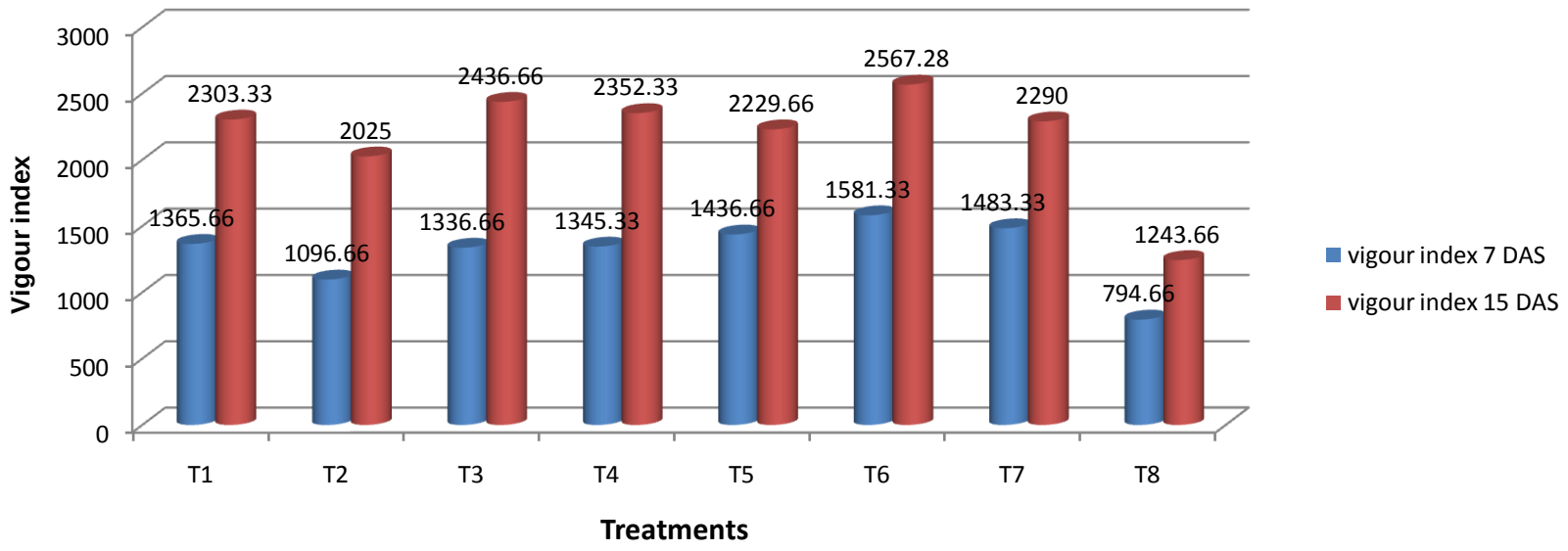
Evaluation of liquid organic manures on growth and yield of oriental pickling melon

5. 2. 1GROWTH CHARACTERS

The treatments receiving organic manures alone recorded higher percentage of germination while it was the lowest in the treatment receiving POP. The seeds treated with Panchagavyam + *Pseudomonas* (all the treatments except POP) enhanced the germination and seedling vigour due to the presence of hormones, enzymes and other growth promoters. Natarajan (2003) also reported enhanced metabolic activity and growth due to the application of Panchagavya.

The treatment receiving liquid extract of composite organic manure (T_{10}) recorded maximum vine length (9.75cm) at15 DAS while T_1 (Jeevamrutham) recorded the highest length of vine (65.91cm) at 30 DAS. T_3 (Fish amino acid) had the maximum vine length at 45 DAS (114.16cm) where asT9 (POP) recorded the minimum length of vines in all stages of the growth (Fig.4).The treatment variation was significant with respect to the number of leaves during the vegetative and reproductive stages. Liquid organic formulations helped to improve the number of leaves. Application of liquid organic manures registered

Fig. 3 Vigour index of seedlings as influenced by the treatments at 7 and 15 DAS



T1. Cowdung slurry (1: 2)

(1part cow dung: 2 parts water)

T2. Cow urine (5%)

T3. Panchagavyam (30%)

T4. Beejamrutham (100%)

T5. Pseudomonas (5%)

T6. $T_3 + T_5$

T7. $T_4 + T_5$

T8. Control

significantly higher plant growth. 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., Shelkeet *al*., 2005 and Prabhakaran, 2008).The results agree with the findings of Mohanalakshmi and Vadivel (2008) where Ashwagandha plant sprayed with Panchagavya (3%) produced higher number of leaves per plant.

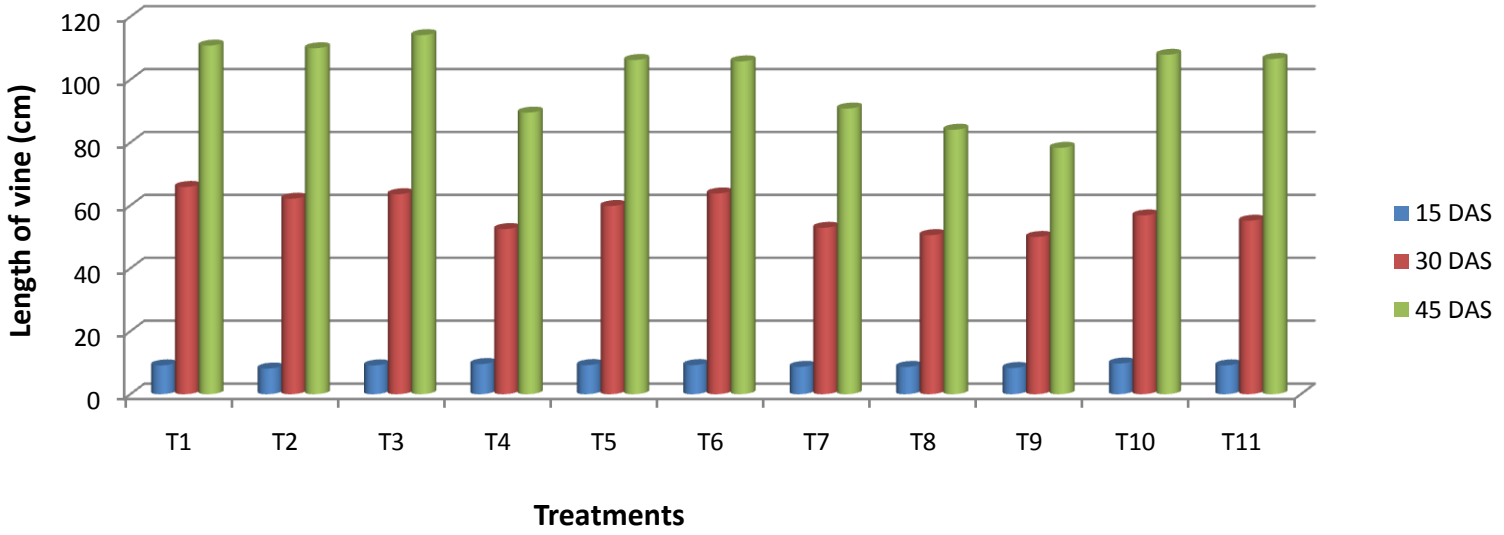
5. 2. 2Physiological characters

The treatments receiving fish amino acid and Jeevamrutham started flowering earlier by 22.66 days while T9 (POP) recorded late flowering by 31 days as depicted inFig.5.The same trend was observed by Abhilash (2011) in red amaranthus and Palekar (2006) in okra, tomato and brinjal. Early harvest could be obtained from the plants receiving green leaf extract by 50.33 DAS while T_9 (POP) took maximum days of 62.66 days to harvest (Fig.5).

Harvesting could be done 3 times from all the treatments except T_9 (POP).The organic manure application might have improved the vegetative growth and extended the reproductive phase. This might be due to the better availability of essential plant nutrients, rapid mineralization and favourable C: N ratio as noticed by Mali *et al.*(2005) and Prabakaran,2008.T_5(Green leaf extract) recorded the highest duration of 80 days while the lowest was noticed in T_9(POP) being 63.33 days. Liquid organic formulations increased the duration of the crop due to growth promoters, enzyme activity and supply of foliar nutrients.

Among the treatments, T_1 (Jeevamrutham) recorded the highest DMP of 96.4 g plant^{-1}.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 photosynthesis and its effective utilization might be another reason for the increased biomass. Improved performance 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

Fig. 4 Length of vine as influenced by the treatments



T_1 Jeevamrutham

T_2 Panchagavyam

T_3 Fish amino acid

T_4 Cow urine

T_5 Green leaf extract

T_6 (T_2 + T_3 + T_5)

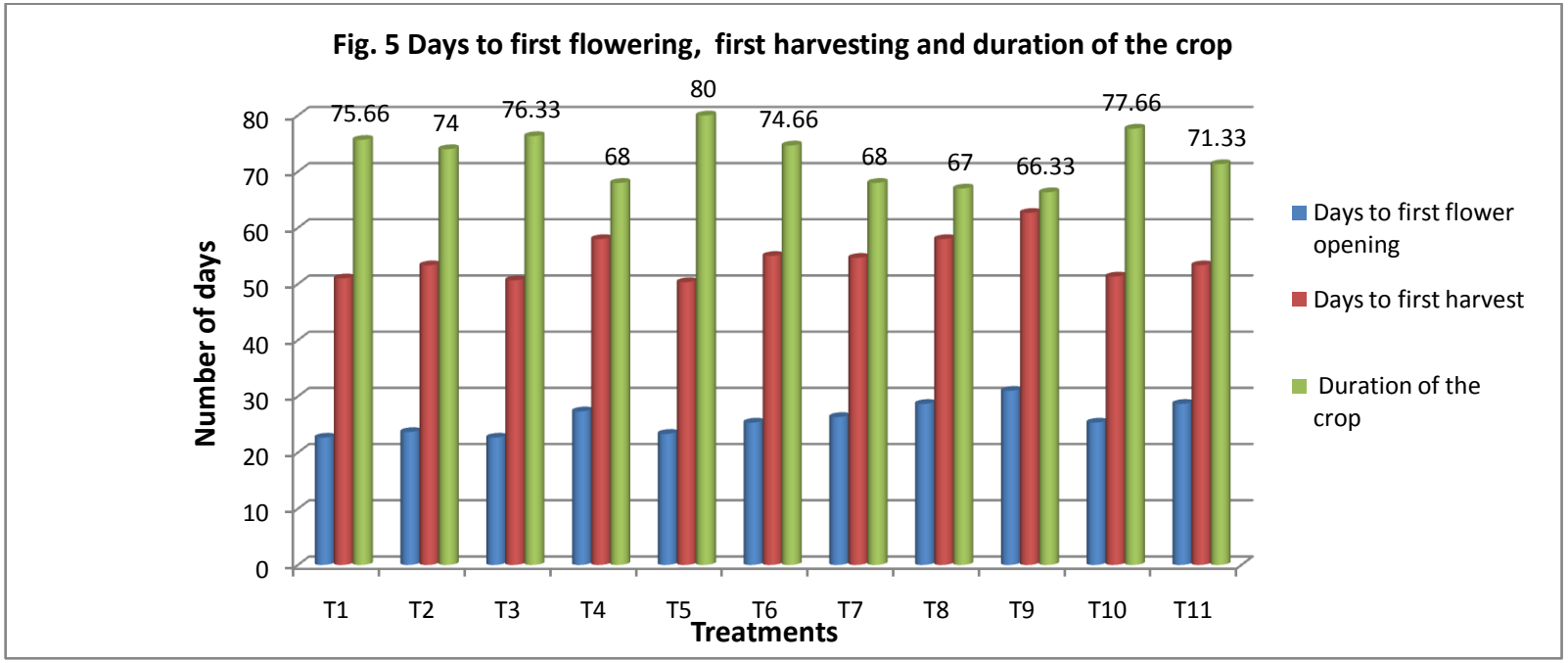
T_7 Control (with water spray)

T_8 Control (without water spray)

T_9 POP

T_{10} Liquid extract of composite organic manure

T_{11} Commercial formulation (Biozyme)



T_1 Jeevamrutham

T_2 Panchagavyam

T_3 Fish amino acid

T_4 Cow urine

T_5 Green leaves extract

T_6 (T_2 + T_3 + T_5)

T_7 Control (with water spray)

T_8 Control (without water spray)

T_9 POP

T_{10} Liquid extract of composite organic manure

T_{11} Commercial formulation (Biozyme)

more DMP (Subbaiah and Asija, 1956). Similar results were obtained by Babalad (2005), Dhananjaya (2007) and Shijini (2010).

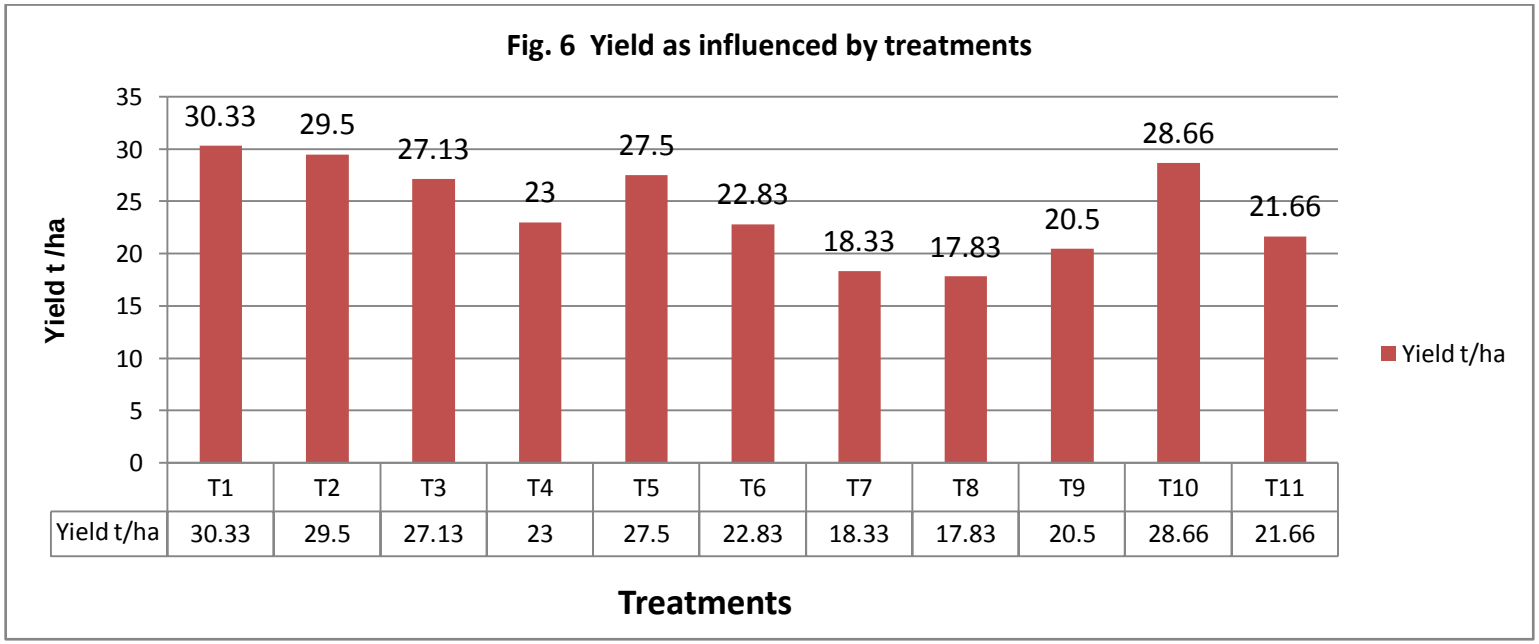
Chlorophyll content was also more in plants receiving liquid organic manures. Chlorophyll content increased gradually in all the treatments compared to T_9 (POP) because of more enzyme activity and production of growth promoters (Krishnan, 2014).The results agree with the findings of Gathala *et al*. (2007), where the 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.

5. 2. 3YIELD AND YIELD ATTRIBUTES

T1 (Jeevamrutham) recorded the highest number of fruits (3.83) followed by T_2 (Panchagavyam) whereas the lowest number of fruits (2.24) was observed in T_8 (Control without water spray). The growth regulators viz. GA and IAA present in Jeevamrutham and Panchagavyam might have been favourable for cell elongation and increase in physiological activities leading to better yield. The results agree with the findings of Somasundaram *et al.* (2003) and Thimma (2006).

Jeevamrutham contributed the highest volume of fruits (770cm³) followed by fish amino acid (755cm³). Chandrakala (2008) also noticed similar results where the combined application of Beejamrutham, Jeevamrutham and Panchagavyam increased the volume of the fruit in chilli.

T1 (Jeevamrutham) recorded the maximum weight of fruits (2.5 kg/ plant) followed by T_2Panchagavyam (2.43 kg/ plant). Similar results were observed in tomato where a combined application of Beejamrutham, Jeevamrutham and Panchagavyam (1:1:2) at75 and 160 DAS increased the fruit volume and yield (Gore, 2009).



T_1 Jeevamrutham

T_2 Panchagavyam

T_3 Fish amino acid

T_4 Cow urine

T_5 Green leaves extract

T_6 ($T_2 + T_3 + T_5$)

T_7 Control (with water spray)

T_8 Control (without water spray)

T_9 POP

T_{10} Liquid extract of composite organic manure

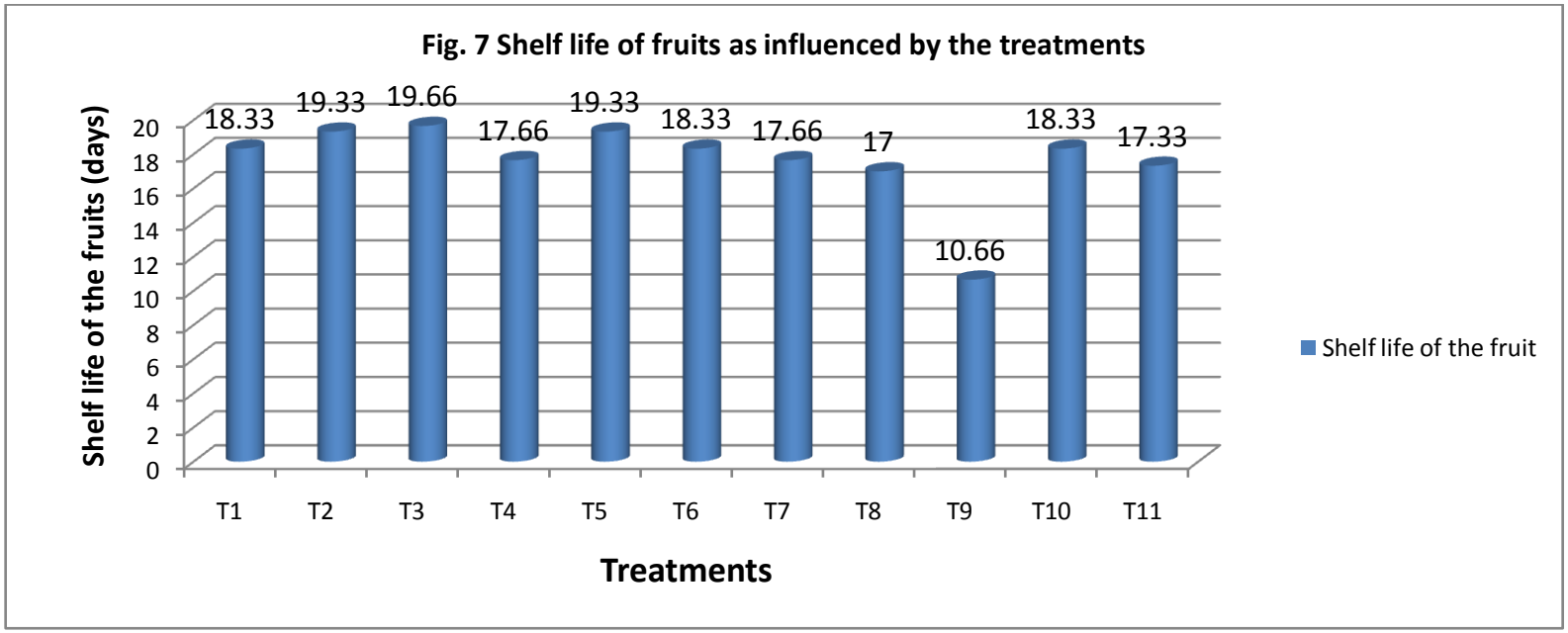
T_{11} Commercial formulation (Biozyme)

The yield of oriental pickling melon was significantly influenced by different treatments as evident from Fig.6.T_1 (Jeevamrutham) recorded the highest yield (30.33 t ha^{-1}) followed by T_2 (Panchagavyam). The lowest yield (17.83tha^{-1}) was observed in T_8 (Control without water spray).The same trend was observed by (Mohan and Srinivasan, 2008) in brinjal and (Gore, 2009) in tomato and Chandrakala (2008) in chilli. Enormous amount of microbial load in Jeevamrutham should have multiplied in the soil contributing better crop growth and yield. The findings that the microbial properties and nutrient availability under different organic input regimes suggest the need for effective residue management in organic farming systems (Tu *et al* ., 2006).The foliar spray of liquid formulations facilitated instant uptake of nutrients which might have led to the effective conversion of vegetative phase to reproductive phase which the growth and yield. Abhilash (2011) also reported 20% increase in growth, and yield of red Amaranthus with foliar spray of Fish amino acid.

5. 2. 4. QUALITY ATTRIBUTES

Fish amino acid(T_3)recorded the maximum shelf life of 19.66 days followed by 19.33 days in T_2 (Panchagavyam) and T_5 (Greeen leaf extract).The minimum shelf life of fruit (10.66 days) was found in T_9 (POP). All the organic liquid formulation treatments recorded more shelf life compared to POP as shown inFig.7.

Higher shelf life might be attributed to the phenomenon of altered physiological and biological constituents of fruit as influenced by organic manures and that might have led to the reduced respiration and enzyme activity which in turn resulted in higher storage life. This confirms the findings of Linder (1985) and Shijini (2010).Joseph (1998) also noticed the favourable influence of poultry manure in increasing the shelf life. 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 brinjal.



T_1 Jeevamrutham

T_2 Panchagavyam

T_3 Fish amino acid

T_4 Cow urine

T_5 Green leaves extract

T_6 (T_2 + T_3 + T_5)

T_7 Control (with water spray)

T_8 Control (without water spray)

T_9 POP

T_{10} Liquid extract of composite organic manure

T_{11} Commercial formulation (Biozyme)

Organoleptic quality test revealed the superiority of organic treatments over the POP (T_9). In the acceptability test, the panelist preferred organically grown oriental pickling melon to the chemically grown variant when they assessed the colour, taste, texture and flavour. The highest score for all characters in organoleptic test was observed in the treatment receiving Panchagavyam and Fish amino acid as foliar spray. The same trend was observed by Krishnan (2014) in salad cucumber.

5. 2. 5Incidence of pests and diseases

No severe attack of pests and diseases was observed in experimental plots. However, the attack of pumpkin beetle, fruit fly, aphids and termites could be noticed especially in treatments not receiving liquid organic manures. The attack was controlled by spraying of Neemsoap, *Beuveria* and *Metarrhizium*.

The organic manures viz. Poultry manure, groundnut cake 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 The vanathan (2010b) and Krishnan (2014). The secondary metabolites produced by the beneficial micro organisms in Panchagavyam might have helped to prevent the attack of pests and diseases.

5. 2. 6. Soil characters

The initial pH of the soil was 5.03. The treatment receiving Fish amino acid (T_3) recorded the highest pH (6.21) after the experiment, which was followed by Jeevamrutham (T_1). Application of organic manures including liquid manures might have contributed to the increase in pH (Lal *et al*., 2000). Olsen (1972) also observed that addition of manures increases the soil pH.

The EC of the soil was considerably reduced by the application of organic manures and liquid organic manures. The initial content of organic carbon of the soil was 1.22%. After the experiment the value ranged from 1.12% in T_9 (POP) to

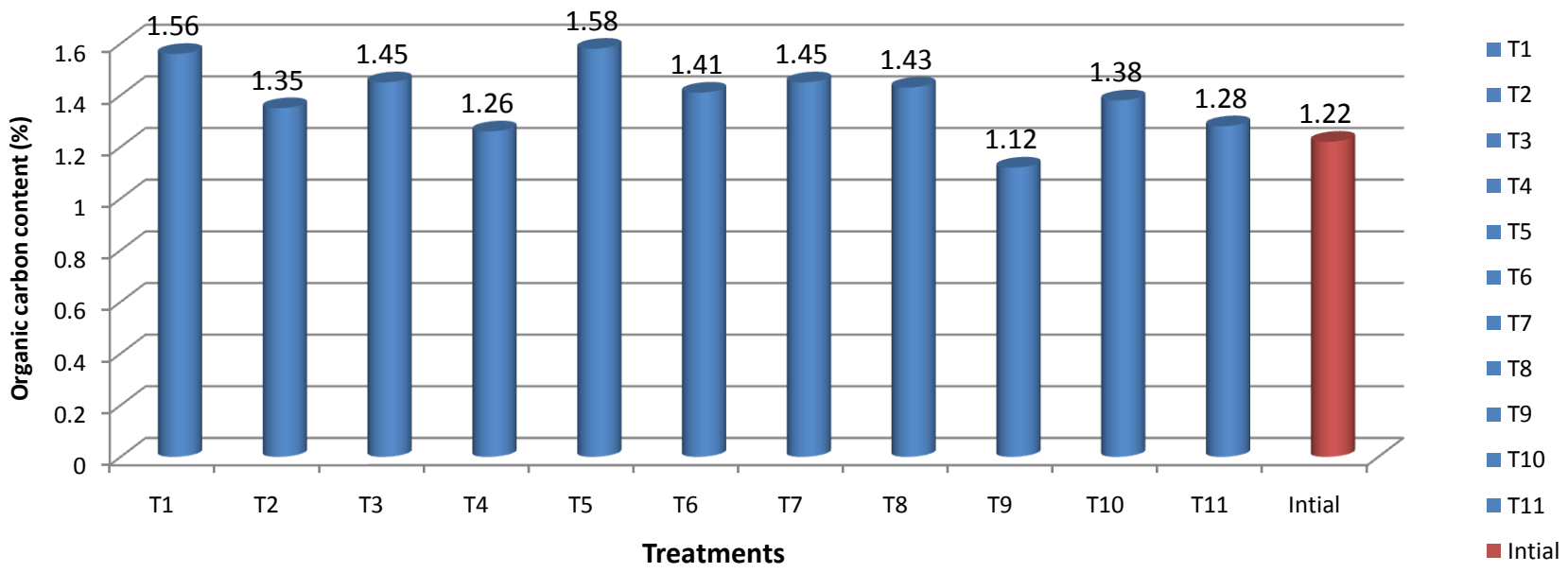
1.58% in T_5 (Green leaf extract) as depicted inFig.8.The increase inorganic carbon content of soil under organic farming is quite obvious since the carbonaceous materials contribute to soil organic carbon after their decomposition. The results agree with the findings of Ravishankar *et al*. (2008) where the addition of FYM, vermicompost, neem cake and bio fertilizers significantly contributed to the improvement in soil organic carbon content. The same trend was observed by Hangarge *et al*. (2004).

Application of organic amendments might have improved the 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 highest available nitrogen content was recorded in T_1 (Jeevamrutham) with a value of 489 $kgha^{-1}$which was significantly superior to other treatments followed by T_5 (Green leaf extract) 472.7 $kgha^{-1}$. 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 intoNH_4^+ N and NO_3^- N as observed by Kara *et al*. (2007).

Liquid extract of composite organic manure contributed the maximum content of available phosphorus of 25.42$kgha^{-1}$. The treatments significantly influenced the available potassium content of soil after the experiment. The highest available potassium content was recorded in T_5 (Green leaf extract)being 309.49 kg ha^{-1}.The major effect of Vermicompost application in soil was the reduction in P fixation and thus increasing P availability in acid soils as reported by Baiju *et al*.(2009). The lowest content of K was recorded in T_9 (POP) with a value of 251.62 kg ha^{-1}.Similar results were obtained by Magray *et al*. (2011) in tomato when Cowdung slurry was applied.

Fig. 8 Organic carbon content of soil as influenced by the treatments



T_1 Jeevamrutham

T_2 Panchagavyam

T_3 Fish amino acid

T_4 Cow urine

T_5 Green leaves extract

T_6 ($T_2 + T_3 + T_5$)

T_7 Control (with water spray)

T_8 Control (without water spray)

T_9 POP

T_{10} Liquid extract of composite organic manure

T_{11} Commercial formulation (Biozyme)

5. 2. 7 Microbial population in soil

Different liquid organic manuring treatments significantly increased the microbial population (fungi, bacteria and actinomycetes) in the soil. Application of poultry manure and combined application of neem cake, ground nut cake and coir pith compost were found to be good for biological activity (Krishnan, 2014).

The initial population of fungi, bacteria and actinomycetes were 10 cfu g^{-1}, 16 cfu $g^{-1}$and 8 cfu g^{-1}, respectively. The treatment receiving Panchagavyam recorded the highest fungal population at 15 DAS whereas at 30 DAS liquid extract of composite organic manure showed the highest microbial population. The Jeevamrutham treatment received highest bacterial and actinomycetes population. All the organic manures and formulations applied treatments showed increase in microbial population compared to POP. Population of fungi, bacteria and actinomycetes was the least in the treatment which received inorganic fertilizers.

The highest microbial population in the case of all organic treatments could be attributed to favourable effects of manures 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). These results are in agreement with the present results where the application of liquid formulations has increased the microbial population.

Poultry manure application has increased the dehydrogenase activity which is a reliable indicator of soil microbial status (Reddy and Reddy, 2005). Palekar (2007) also reported that Jeevamrutham contributes enormous amount of microbial load in the soil.

5. 2. 8 Characteristics of liquid formulations

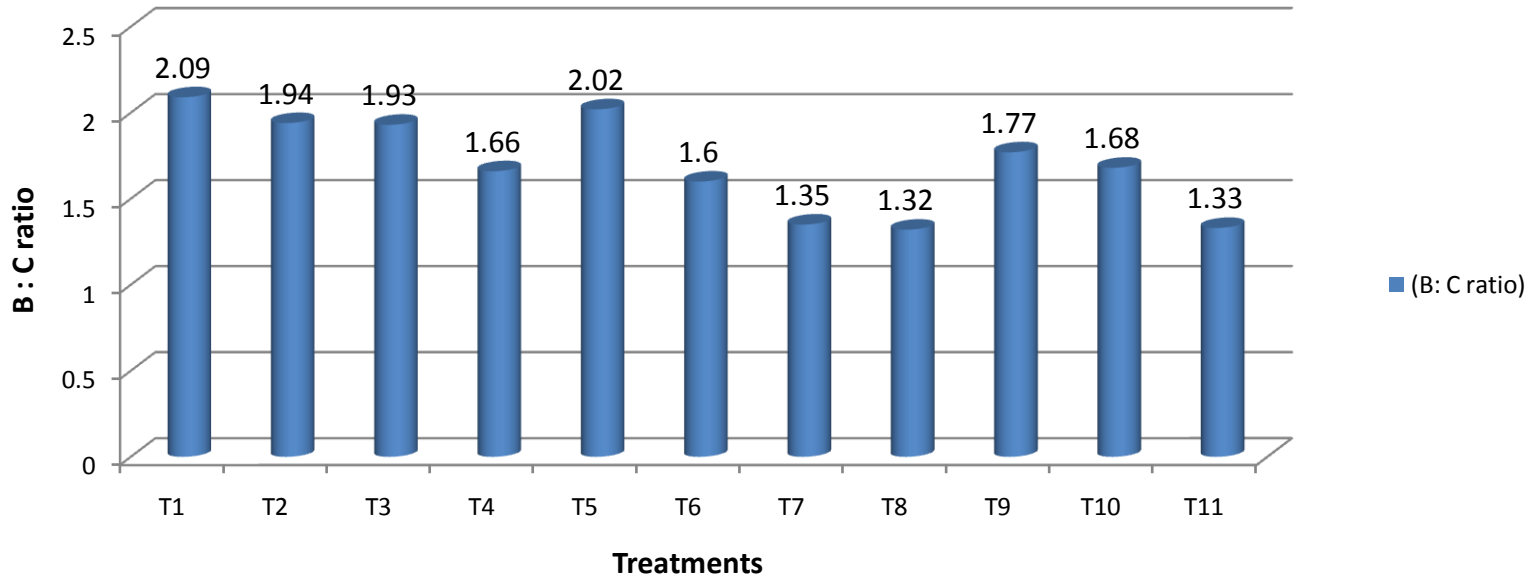
Panchagavyam and fish amino acid were found to be acidic while the remaining formulations were near neutral. Panchagavyam contained the highest fungal and bacterial microbial population (43.33cfu /g and 87.66 cfu /g) followed by Jeevamrutham. The growth promoters and nutrient content in these formulations might have favoured the increase in microbial count as observed by Natarajan, 2003.

5. 2. 9 ECONOMIC ANALYSIS

The data on economic analysis revealed the significant difference in B: C ratio among the treatments. T_1 (Jeevamrutham) was found to be significantly superior to other treatments with regard to gross return, net return and B: C ratio followed by T_5 (Green leaf extract). T_1 (Jeevamrutham) achieved a B: C ratio of2.09 while the present package of practices recommendation recorded the B: C ratio of only 1.77 (Fig.9). The highest B: C ratio could be achieved due to the increase in yield. The ratio can be increased further if we could sell the fruits at premium price.

The economics of organic farming cannot be worked out merely based on yield. It encompasses the entire process and effects of organic farming in terms of benefits to human society.

Fig. 9 B: C ratio as influenced by the treatments



T_1 Jeevamrutham

T_2 Panchagavyam

T_3 Fish amino acid

T_4 Cow urine

T_5 Green leaves extract

T_6 (T_2 + T_3 + T_5)

T_7 Control (with water spray)

T_8 Control (without water spray)

T_9 POP

T_{10} Liquid extract of composite organic manure

T_{11} Commercial formulation (Biozyme)

Summary

6. SUMMARY

The present investigation on "Liquid formulations for production of organic oriental pickling melon (*Cucumis melo* var. *conomon* L.)" was carried out in College of Horticulture, Kerala Agricultural University, Vellanikkara, Thrissur during 2013- 2014.The variety Saubhagya was used for the study. The summary of the findings is presented below.

EXPERIMENT I

Effect of seed treatment with liquid formulations on germination and seedling vigour in oriental pickling melon

- The highest germination percentage (100%) was recorded in seeds treated with Panchagavyam.
- Root and shoot length of seedlings was the highest in Panchagavyam+ *Pseudomonas* treated seeds.
- Fresh weight and dry weight of plants was the highest in the treatment receiving Panchagavyam+ Pseudomonas.
- Vigour index was the highest in Panchagavyam (2567.28) followed by Beejamrutham treated plants.

EXPERIMENT II

Evaluation of liquid organic manures on growth and yield of oriental pickling melon.

- The organic carbon content of plots receiving organic treatments was increased to a tune of 35- 90% and the highest content of 1.58%was observed in the plots receiving Green leaf extract.
- The highest available N content was recorded in Jeevamrutham (489 kg $ha^{-1)}$ which was significantly superior to other treatments. Liquid extract of composite organic manures recorded the maximum available P (25.42 kg $ha^{-1)}$ while the available K (309.5 kg $ha^{-1)}$ content was the highest in Green leaf extract treatment.

- With regard to the soil microbial count at different intervals of crop growth, the treatment receiving liquid extract of composite organic manures resulted in the highest fungal population. Jeevamrutham treated plots had the highest bacterial and actinomycetes population. All the micro organisms were minimum in the treatment receiving POP.
- Among the liquid formulations, the NPK content was more in the liquid extract of composite organic manures and fish amino acid.
- The highest fungal and bacterial count was recorded in Panchagavyam treated plots.
- The seeds treated with *Pseudomonas* + Panchagavyam and organic manures alone as basal dose showed better germination and seedling growth.
- The length of vine was the highest in Fish amino acid (114.16 cm) followed by Jeevamrutham and Panchagavyam treatments.
- The number of leaves were also maximum in Fish amino acid (37.66) followed by Jeevamrutham treatments.
- Early flowering and harvesting could be achieved in Fish amino acid (22.66 and 50.66 DAS respectively) treated plots.
- Dry matter production was the highest in the treatment receiving Jeevamrutham (94.6 g) followed by Green leaf extract (90.13 g).
- Maximum duration of the crop was noticed in the treatment receiving Fish amino acid (80 days).
- The highest chlorophyll content was observed in Green leaf extract (1.62 mg/g) followed by Jeevamrutham (1.60 mg/g).
- Number of fruits / plant was maximum in Jeevamrutham (3.83) followed by Panchagavyam (3.73).The weight of the fruits was also the highest in Jeevamrutham (2.5 kg) followed by Panchagavyam (2.43 kg).
- Volume of the fruits recorded the highest value for Jeevamrutham (770 cm^3) followed by Panchagavyam (751.66 cm^3).

- The highest yield was recorded in Jeevamrutham treated plots (30.33 tha^{-1}) followed by Panchagavyam (29.50tha^{-1}) treated plots.
- Shelf life of the fruits was the maximum in fish amino acid (19.66 days) followed by Panchagavyam (19.33 days).
- The organoleptic test revealed the superiority of organically grown cucumber to the chemically grown variant. Jeevamrutham, Panchagavyam and Fish amino acid treated plants produced better quality fruits obtained the and recorded highest score in organoleptic qualities among the treatments.
- Pest and disease incidence was less in plots sprayed with liquid formulations compared to the treatment receiving POP.
- Jeevamrutham treatment secured the highest B: C ratio of 2.09 followed by Green leaf extracts (2.02).

CONCLUSION

The study on "Liquid Formulations for Production of Organic Oriental Pickling Melon (*Cucumis melo* var. *conomon L.)"* revealed the positive effect of organic liquid formulations in improving the germination, growth, yield and quality. Among the formulations tried, Jeevamrutham was found to be superior for production of organic oriental pickling melon.

FUTURE LINE OF WORK

- Scientific analysis of the reasons for the positive response of liquid organic formulations.
- Shelf life of liquid organic formulations is to be studied.
- Long term trials to compare the organic farming with conventional farming as in LTFE.

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Appendices

Appendix I . Physico - chemical properties of soil

Particulars	Content	Method used
Physical properties		
1.Particle size composition Coarse sand (%)	31.90	Robinson international pipette method (Piper, 1942)
Fine sand (%)	27.30	
Silt (%)	18.64	
Clay (%)	22.16	
Chemical properties		
1. pH	5.03	1: 2.5 soil water ratio Beckman glass electrode (Jackson, 1973)
2. EC (dS/m)	0.011	Conductometric method (Jackson, 1973)
3. Organic carbon (%)	1.22	Walkley and Black method (Jackson, 1973)
4. Available N (kg/ha)	313.5	Alkaline permanganate method (Subbiah and Asijah, 1956)
5. Available P (kg/ha)	15.17	Ascorbic acid reduced molybdophosphoric blue colour method (Watnabe and Olsen, 1965)
6. Available K (kg/ha)	232.76	Neutral normal ammonium acetate extractant flame photometry (Jackson, 1973)

Appendix II. Meteorological data during the crop growing period

Standard Week	Max. Temp. ($_0$C)	Min. Temp. ($_0$C)	Mean RH (%)	Wind speed (km/hr)	Mean sun shine hrs	Rain fall (mm)	Rainy days Mean	evaporation (cm)	Soil Temperature (^{0}C)					
									Morning			Evening		
									5cm	10cm	15cm	5cm	10cm	15cm
47	32.9	23.9	94	1.4	5.4	13.2	1.0	17.6	25.9	26.1	26.8	35.6	32.9	31.4
48	32.8	24.0	92	2.4	5.3	6.8	1.0	16.9	25.5	25.9	26.6	35.0	32.4	31.2
49	32.5	22.4	81	3.2	7.9	0.0	0.0	25.1	24.4	25.0	26.1	37.0	33.9	32.2
50	32.3	22.5	87	4.2	8.3	0.5	0.0	24.4	24.9	25.6	26.8	37.5	34.2	32.6
51	31.2	21.8	71	7.3	9.7	3.0	0.0	34.6	24.2	25.4	26.4	38.2	34.2	32.5
52	31.4	22.1	66	7.4	9.2	0.0	0.0	40.9	24.4	25.4	26.4	37.9	33.7	32.3
1	32.9	22.4	74	5.5	9.2	0.0	0.0	35.3	25.1	26.0	27.1	39.4	34.8	33.2
2	32.8	23.1	68	6.3	8.1	0.0	0.0	36.1	26.2	26.9	28.0	39.7	35.2	33.7
3	33.0	23.7	63	6.8	8.6	0.0	0.0	39.4	26.4	27.5	28.4	40.0	35.3	33.9
4	32.7	23.3	63	8.2	9.6	0.0	0.0	43.2	26.3	27.1	28.2	39.9	34.8	33.2
5	33.9	22.3	60	7.2	9.8	0.0	0.0	41.3	26.2	27.1	28.1	40.8	35.4	33.7
6	35.2	21.0	74	3.8	9.8	0.0	0.0	37.6	25.9	27.0	28.2	42.0	36.0	34.2
7	33.5	22.6	89	2.5	6.8	0.0	0.0	25.9	27.7	28.4	29.4	40.8	35.5	34.2
8	35.2	24.3	70	5.8	8.2	0.0	0.0	41.0	28.8	29.5	30.5	43.7	36.7	35.5
9	35.2	24.7	77	3.3	8.6	0.0	0.0	40.9	30.0	30.5	31.6	44.2	38.1	36.8
10	35.2	25.0	71	5.4	7.3	0.0	0.0	43.4	30.2	30.7	32.0	43.3	37.9	36.8
11	37.5	22.3	67	4.7	9.5	0.0	0.0	52.3	28.0	29.5	30.7	45.3	38.1	36.6
12	37.5	24.9	87	2.9	8.8	0.0	0.0	41.4	31.0	31.7	32.8	46.8	39.8	37.3
13	38.1	23.1	73	2.4	5.7	0.0	0.0	12.3	39.0	35.7	35.4	46.9	40.1	38.4

Appendix III. Media used for enumeration of microorganisms in soil and liquid formulations

SI NO	Microbes	Dilution for plating	Medium	Reference
1	Bacteria	10^6	Nutrient Agar	(Agarwal and Hasija,1986)
2	Fungi	10^4	Martin's Rose Bengal Agar	(Agarwal and Hasija,1986)
3	Actinomycetes	10^5	Kenknight	(Agarwal and Hasija,1986)

Appendix IV. 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}
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

LIQUID FORMULATIONS FOR PRODUCTION OF ORGANIC ORIENTAL PICKLING MELON

(*Cucumis melo* var. *conomon L.)*

By

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(2012-11-194)

ABSTRACT OF THE THESIS

Submitted in partial fulfillment of the requirement for the degree of

Master of Science in Agriculture

Faculty of Agriculture

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KERALA, INDIA

2014

ABSTRACT

The study on "Liquid formulations for production of organic oriental pickling melon (*Cucumis melo* var. *conomon* L.)" was carried out in College of Horticulture, Kerala Agricultural University, Vellanikkara, Thrissur during 2013-2014. There were two experiments viz. Effect of seed treatment with liquid formulations on germination and seedling vigour in oriental pickling melon and Evaluation of liquid organic manures on growth and yield of oriental pickling melon. The seeds treated with liquid organic manures showed better results in all observations such as germination percentage, length of radicle, length of plumule, dry weight, fresh weight and vigour index. The treatments receiving Panchagavyam+ Pseudomonas, Beejamrutham+ Pseudomonas, Panchagavyam and cow dung slurry were superior in early germination and seedling growth.

The second experiment consisted of 11 treatments including different combinations of organic manures and supplements and package of practices recommendation by KAU. Saubhagya variety of oriental pickling melon was used for the study. The organic manures viz. poultry manure, coir pith compost, ground nut cake, neem cake and liquid organic manures viz. Jeevamrutham, Panchagavyam, Fish amino acid, Green leaf extract and Liquid extract of composite organic manures were the sources of nutrients. All the treatments except T_9 were given basal and top dressing applicaton of organic manures as per the Package of practices recommendations (Adhoc) for organic farming : Crops. Seeds except in T_9 were treated with (Panchagavyam+ *Pseudomonas)* and have shown early germination and seedling vigour.

Growth parameters like length of vine, number of leaves, dry matter production were significantly influenced by the treatments. The treatment receiving Fish amino acid recorded the highest length of vine (114.16cm) and number of leaves (37.66). Early flowering and harvesting could be achieved in Fish amino acid (22.66

and 50.66 DAS respectively) treated plots. Jeevamrutham treated plants had the highest dry matter production of 96.4g.

Yield and yield attributes like number of fruits per plant, mean fruit weight, volume of fruit and yield per ha were also significantly influenced by the application of different liquid organic formulations. Highest number of fruits per plant (3.83) and weight of fruits (2.5 kg/plant), volume of fruit (770 cm^3) and yield per ha (30.33 t/ha) were observed in Jeevamrutham and Panchagavyam treated plots.

With regard to the soil microbial count at different intervals of crop growth, the treatment receiving liquid extract of composite organic manure resulted in highest fungal population meanwhile Jeevamrutham had the highest bacterial and actinomycetes population . All the micro organisms were minimum in the treatments receiving Package of Practices recommendations of KAU. With regard to microbial count in liquid formulations the highest fungal and bacterial count was recorded in Panchagavyam followed by Jeevamrutham. NPK content was more in liquid extract of composite organic manure followed by fish amino acid. 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, texture, taste and colour was noticed in the treatment receiving Jeevamrutham followed by Panchagavyam and Fish amino acid. The overall acceptability was also more for the fruits from the organically treated plots. The treatment receiving Jeevamrutham was found to be significantly superior to other treatments in getting higher gross income, net return and B: C ratio followed by Green leaf extract and Panchagavyam.