Response of Shalimar Tomato Hybrid-1 to Organic and Inorganic Sources of Plant Nutrients

Mohammad Mudasir Magray
(2008-A-822-M)

Faculty of Postgraduate Studies
Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir

2011

Response of Shalimar Tomato Hybrid-1 to Organic and Inorganic Sources of Plant Nutrients

Mohammad Mudasir Magray
(2008-A-822-M)

THESIS

Submitted to

The Faculty of Postgraduate Studies
Sher-e-Kashmir
University of Agricultural Sciences & Technology of Kashmir in partial fulfilment of requirement for the award of the degree of

MASTER OF SCIENCE IN AGRICULTURE
(Olericulture)

2011

Dedicated

to my Parents

Sher-e-Kashmir
University of Agricultural Sciences & Technology of Kashmir
Division of Olericulture, Shalimar Campus, Srinagar
-::o::-

CERTIFICATE – I

This is to certify that the thesis entitled **"Response of Shalimar Tomato Hybrid-1 to Organic and Inorganic Sources of Plant Nutrients"** submitted in partial fulfilment of the requirements for the award of the degree of **Master of Science in Agriculture (Olericulture)**, to the Faculty of Postgraduate Studies, Sher-e-Kahsmir University of Agricultural Sciences and Technology of Kashmir, is a record of bonafide research work carried out by **Mr. Mohammad Mudasir Magray (Regd. No. 2008-A-822-M)** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

It is further certified that information received during the course of investigation has duly been acknowledged.

(Dr. M. A. Chattoo)
Chairman
Advisory Committee

Endorsed

Head,
Division of Olericulture

Sher-e-Kashmir
University of Agricultural Sciences & Technology of Kashmir
Division of Olericulture, Shalimar Campus Srinagar
-::o::-

CERTIFICATE – II

We, the members of the Advisory committee of **Mr. Mohammad Mudasir Magray (Regd. No. 2008-A-822-M)**, a candidate for the degree of **Master of Science in Agriculture (Olericulture)**, have gone through the manuscript of the thesis entitled, **"Response of Shalimar Tomato Hybrid-1 to Organic and Inorganic Sources of Plant Nutrients"** and recommend that it may be submitted by the student in partial fulfilment of the requirements for the award of degree.

ADVISORY COMMITTEE

Chairman

Dr. M. A. Chattoo
Associate Professor,
Division of Olericulture,
SKUAST-K, Shalimar

Members

Dr. K.P. Wani,
Associate Professor,
Division of Olericulture,
SKUAST-K

Dr. G.R. Najar,
Associate Professor,
Division of Soil Science,
SKUAST-K

Dr. Showket Maqbool,
Assistant Professor,
Division of Agri-Statistics,
SKUAST-K

Dr. Tahir Hussain,
Associate Professor,
Division of Agri-Statistics,
SKUAST-K **(Dean PG Nominee)**

Sher-e-Kashmir
University of Agricultural Sciences & Technology of Kashmir
Shalimar Campus Srinagar – 191 121
-::o::-

CERTIFICATE – III

This is to certify that the thesis entitled, **"Response of Shalimar Tomato Hybrid-1 to Organic and Inorganic Sources of Plant Nutrients"** submitted by **Mr. Mohammad Mudasir Magray (Regd. No. 2008-A-822-M)** to the Faculty of Postgraduate Studies, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, in partial fulfilment of the requirements for the award of the degree of **Master of Science in Agriculture (Olericulture)** was examined and approved by the Advisory Committee and external examiner on ………………..

Chairman
Advisory Committee

External Examiner

Head
Division of Olericulture

Director Resident Instruction-cum-Dean
Postgraduate Studies, SKUAST-K

Sher-e-Kashmir
University of Agricultural Sciences & Technology of Kashmir
Division of Olericulture, Shalimar – 191 121

-::o::-

Name of the student	:	**Mohammad Mudasir Magray**
Registration No.	:	2008-A-822-M
Major subject	:	Olericulture
Minor subjects	:	Soil Science
Major advisor	:	**Dr. M. A. Chattoo,** Associate Professor/Incharge Head, Division of Olericulture , SKUAST-K, Shalimar
Title of the Thesis	:	**"Response of Shalimar Tomato Hybrid-1 to Organic and Inorganic Sources of Plant Nutrients"**

ABSTRACT

The present investigation entitled "Response of Shalimar Tomato Hybrid-1 to Organic and Inorganic Sources of Plant Nutrients" was carried out at Experimental Farm of the Division of Olericulture, SKUAST-K, Shalimar during kharif-2009 and kharif-2010. The experiment was laid in Randomized Block Design replicated thrice at a spacing of 60 x 45 cm. Twelve treatment combination i.e. T_1 (190 N:150 P_2O_5:110 K_2O kg ha^{-1}), T_2 (FYM 38 t ha^{-1}), T_3 (SM 32 t ha^{-1}), T_4 (PM 7 t ha^{-1}), T_5 (VC 14 t ha^{-1}), T_6 (Biofertilizers – *Azospirillium* + *phosphobacter* 2.5 kg ha^{-1}), T_7 (19 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}), T_8 (16 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}), T_9 (3.5 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}), T_{10} (7 t + 95 N: 75 P_2O_5 : 55 K_2O

kg ha^{-1}), T_{11} (2.5 kg Soil inoculant + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}), T_{12} (Control – no organic manure or chemical fertilizers) observations were recorded on growth, yield, fruit quality, chemical characteristics and nutrient availability of studied soil. During both seasons T_9 (3.5 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}), proved better in improving growth and yield attributing traits than other treatment combinations. Maximum plant height (130.06 cm), number of branches (11.46), number of fruits (62.31), fruit diameter (5.25 cm), fruit weight (59.75 g), fruit yield (535.41 q ha^{-1}) were recorded in treatment T_9. The treatment T_9 also exhibited highest fruit quality in terms of vitamin C (25.55 mg/100 g), total soluble solids (5.23 ^{o}Brix), lycopene content (11.36 mg/100 g), protein content (1.69 %), acidity (0.57%).

Treatment T_9, recorded significantly higher values for organic carbon content (1.28%, 1.30%), soil pH (6.97, 6.85), electrical conductivity (0.126 dsm^{-1}, 0.129 dsm^{-1}) available nitrogen (280.91 kg ha^{-1}, 284.30 kg ha^{-1}), available phosphorus (46.01 kg ha^{-1}, 47.60 kg ha^{-1}) available potassium (219.81 kg ha^{-1}, 222.27 kg ha^{-1}), during both seasons after the harvest of crop. Economic studies indicated that highest gross returns of Rs. 388050.00, was obtained in treatment T_4 (PM 7 t ha^{-1}) with maximum returns of 5.28 Re^{-1} invested.

Key words : Tomato, Organic manure, Chemical fertilizers, Growth, Quality and Yield

Signature of Student | Signature of Major Advisor

Dated : ___________ | Dated: ________________

ACKNOWLEDGEMENT

All praises are due to Allah, the Creator and Sustainer of the World and endless blessings of Allah be upon Mohammad [SAW] the great benefactor of mankind

I express my sincere and profound gratitude to Dr. M. A. Chattoo, Associate Professor, Division of Olericulture , SKUAST-K, Chairman of my Advisory Committee for his leadership, valuable guidance during the entire course of investigation and his candid and constructive criticism during the preparation of this manuscript.

With the same spirit and respect I would like to express my deep sense of gratitude to members of my advisory committee, Dr. K.P. Wani, Associate Professor, Division of Olericulture; Dr. G.R. Najar, Associate Professor, Division of Soil Science; Dr. Showket Maqbool, Assistant Professor, Division of Agri-Statistics and Dr. Tahir Hussain, Associate Professor, Division of Agri-Statistics (Dean PG Nominee) for their valuable suggestions and advice during the study programme and for the finalisation of the manuscript.

It is my privilege to place on record my profound gratitude to Dr. Shabir Hussain Khan, Associate Professor/Incharge Head, Division of Olericulture for his valuable suggestions, constructive criticism, encouragement and affection throughout my course work and research programme.

I am highly grateful to all the Faculty members of Division of Olericulture Dr. Nayeema Jabeen, Dr. Sumiti Narayan, Mr. Mohd. Iqbal Makhdoomi, Ms. Shanaz Mufti, Ms. Faheema Mushtaq, Ms. Baseerat Afroz. Mr. Khurshid Ganie for their constant encouragement, support and guidance during the study programme.

Special thanks to Dr. G.R. Najar, Associate Professor, Division of Soil Science, FOA, Wadura for his constant encouragement and proper guidance.

I am also thankful to all the Technical staff members and Non-Teaching staff for their help and support.

I also extend thanks to my colleagues and friends Mudasir, Hilal Ahmad, Imtiyaz Wani, Imran Ahmad, Iqbal Jeelani, Anwar, Nazir Hussain, Sonam Dawa, Shoaib Kirmani, Altaf, Fayaz, Mushtaq Ali, Shabir, Parvez, Aabid, Haseeb, Juniaf, Umaiyah, Asima and Feroz have also earned an applause from me for their affection and courage. Their sweet memories will certainly remain as esteemable wealth for years to come.

I also acknowledge sincere thanks to the staff members of Central Library and ARIS, SKUAST-K, Shalimar for rendering all possible help while collecting the research literature.

It would be my bounded duty to put on record a line of utmost gratitude to my beloved father – Mr. Mohd. Sidiq Magray and mother Mrs. Taslema Bano who as a matter of fact have been real source to put me on the horizon of this success.

With due reverence and gratitude, I express my special thanks to my affectionate brothers and sisters – Mr. Adil Magray, Mr. Arif Magray, Ms. Nighat Jan, Ms. Rukaya, Mr. Javid and Mr. Zahoor, for the support, cooperation, untoward sacrifices and patience in bearing with me throughout the period of my studies at the cost of their personal comfort.

Finally I extend my sincere thanks to Mr. Younus Ahmad and Mr. M. Rafiq of M/s Universal Computers, Shalimar for taking lot of pains and care in composing this manuscript beautifully in shortest possible time.

Mohammad Mudasir Magray

Place : Shalimar, Srinagar

Dated :

CONTENTS

LIST OF TABLES

CHAPTER – 1

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) belongs to family Solanaceae, is an annual vegetable crop grown throughout the world and ranks second in importance after Potato. The tomato is believed to have been originated in Central Africa and South America (Vavilov, 1951). In India it is an introduced crop and is being grown on an area of 571.7 thousand hectares with an annual production of 10260.6 thousand metric tonnes (Anonymous, 2008). In Jammu and Kashmir State, tomato is grown on an area of 1.7 thousand ha with an annual production of 37 thousand metric tonnes (Anonymous, 2008). Tomato is a highly nutritious vegetable besides having medical importance that is why it is referred to as protective food. Tomato is known for its nutritive value, because of its high pro-vitamin A and Vitamin C content and ranks number one in the contribution to the diet. It is a rich source of minerals, vitamins, organic acids and has 3.6% carbohydrates, 0.1% fat, 1.9 % proteins, 0.7% fibre, 320 I.U. of Vitamin A and 0.6% minerals besides, containing a Vitamin C content of 31 mg 100 g^{-1} of fresh fruit weight. In addition to nutritional importance, tomato has medicinal significance also. It is considered to be a very good appetizer/blood purifier and a good remedy for patients suffering from constipation. Tomato is consumed both raw as well as in the cooked form. Several processed items of tomato like paste, puree, syrup, juice, ketchup and drinks are prepared on large scale. Tomato produces fruits for a longer period and thus needs sufficient supply of plant nutrients both macro and micro for higher yield and better quality. With the introduction of hybrids, the demand for nutrients has significantly increased because of their tremendous yield potential as compared to traditional varieties thus for harnessing higher yield and better quality in hybrids adequate nutrient supply is a pre-requisite.

For enhancing the yield and quality application of adequate quantities of plant nutrients is a pre-requisite which can be met both from organic as well as inorganic sources. Inadequate or imbalanced nutrient supply is one of the major factor responsible for low production. Substitution of high analysis fertilizers like urea and diammonium phosphate for increasing crop productivity or inadequate use of organic manures have rendered Indian soils deficient in macro and micro- nutrients (Acharya and Mandal, 2002). With rapid increase in population, the demand for the crop has significantly increased, leading to extensive use of chemical fertilizers for supply of plant nutrients without any consideration for soil health, which is a critical factor for realizing sustainable yield of any vegetable crop. Besides, this the residual effects of chemical fertilizers on environment, underground water, soil microflora, vegetable and vegetable products is a matter of concern, as some of the residues like nitrates enter the human body and are carcinogenic. Thus, there is an urgent need to utilize other sources of plant nutrients for sustainable and safe tomato production. The answer lies in the use of organic manures which have a potential to provide primary, secondary and micro-nutrients besides building a strong organic matter base resulting in improvement of soil structure and sustainable vegetable production devoid of most of the harmful residues (Singh *et al.*, 2000). Organic manures are ecofriendly and maintain soil health without polluting soil and underground water. Application of organic manures is a suitable approach for maintenance of soil health and thereby increasing the production. Organic manures are known to improve the quality of vegetable (Singh *et al.*, 2000) and the vegetables produced are preferred for their flavour, taste, lusture, nutritive value and are being sold at premium prices.

It has been observed that neither the chemical sources of nutrients nor the organic sources are able to sustain the soil fertility/productivity and the crop productivity. Organic sources of plant nutrients supply major plant nutrients in moderate quantity as such the soil has to be supplemented with inorganic sources of plant nutrients. The integration has proved superior than individual components with respect to growth, yield and quality in different vegetable crops (Malewar *et al.*, 1998, Bhardwaj *et al.*, 2000; Magray, 2002 and Chattoo *et al.*, 2003).

Biofertilizers are carrier based inoculants of beneficial micro-organisms which are known to enhance the crop productivity due to their ability to fix atmospheric nitrogen and bring about solubulisation of fixed phosphorus besides production of hormones, vitamins and other growth promoting substances (Bhattacharya *et al.*, 2000). Biofertilizers have been found to provide a fertilizer economy of 25 per cent (Chattoo *et al.*, 2003).

Since a meager work with this regard has been conducted under Kashmir conditions, the present investigation has been undertaken to assess the beneficial effects of organic and inorganic sources of plant nutrients both as sole applications as well as in conjugation on Shalimar tomato hybrid-1 with the following objectives.

- To study the influence of different organic sources of plant nutrients on growth, yield and quality of tomato,
- To workout the suitable combination of organic and inorganic sources of nutrients for realizing higher yield and better quality of tomato, and
- To study the economics of production.

CHAPTER – 2

REVIEW OF LITERATURE

Tomato is an important vegetable crop grown throughout the year in India. It requires an adequate amount of nutrients supply for growth and development. Its nutritional demand can be fulfilled both by organic as well as inorganic sources of plant nutrients. Since very little work has been done on this aspect in Kashmir, so it was felt necessary to undertake the present investigation entitled, "Response of Shalimar Tomato Hybrid-I to Organic and Inorganic Sources of Plant Nutrients".

A fertile soil is the basis of successful and economical farming as continuous cropping results in the depletion of plant nutrients. Maintaining the soil fertility is main problem of vegetable growers, because vegetable being short duration in nature, are generally grown in an intensive cropping system and their nutritional requirement is generally very high (Maynard and Lorenz, 1970) as compared to other crops.

The long term fertility experiments conducted all over the country, since 1965 have shown neither organic source of nutrients nor inorganic source of nutrients can alone achieve yield sustainability at high level under modern intensive farming (Numbiar and Abrol, 1989).

Morever, results also have shown reduction in the productivity over the years associated with deficiencies of S, Zn or B. therefore to avoid such deficiencies in future, it is necessary to evolve and adopt a strategy which will fulfil the nutritional demand of vegetable crops through organic as well as inorganic sources of nutrients.

The application of organic sources of plant nutrients like Farm Yard Manure (FYM), Sheep Manure (SM), Vermicompost (VM), Poultry Manure (PM) and biofertilisers in conjugation with inorganic sources of plant nutrients have maximised the economic yields from a particular vegetable cropping system. Further this approach of nutrient application will increase fertilizer use efficiency and will keep the soil capable of producing at an accelerated rate without being physically, chemically or biologically damaged for sustained crop production on long term basis. The literature pertaining to present investigation is briefly reviewed under the following subheads.

2.1 Growth and yield parameters

Substitution of nutrients through FYM and inorganic sources had a substantial positive effect on yield and quality of vegetables like cabbage, carrot, tomato (Piven *et al*., 1987). Ahmad (1993) reported substitution of nutrients through FYM @ 19 t ha^{-1} for harnessing maximum fruit yield in tomato cv. Pusa Ruby. Malewar *et al*. (1998) reported that combined application of FYM and inorganic sources of plant nutrients was found beneficial in increasing yield of chilli crop.

Application of vermicompost @ 4 t ha^{-1} along with 50 per cent of RFD gave highest fruit yield in tomato (Patil *et al*., 1998). Integration of vermicompost @ 5 t ha^{-1} and 50 per cent RFD registered a significantly higher fruit yield in tomato as compared to the RFD alone (Dass *et al*., 2002). Substitution of NPK plant nutrients and vermicompost in equal proportions recorded maximum fruit yield in tomato (Kolte *et al*., 1999). Sole application of vermicompost had a significant influence on root and shoot weight of tomato (Samawat *et al*., 2001).

Soil application of FYM exhibited a decrease in yield of vegetable crops. However, combined application of recommended dose of NPK along with organic sources of plant nutrients in equal proportions exhibited higher yield (Bhardwaj *et al*., 2000). Combined application of FYM @ 20 t ha^{-1} along with inorganic sources of plant nutrients (100 : 50 : 50 NPK kg ha^{-1}) showed significant influence on fruit yield of tomato (Naidu *et al*., 2001).

Kamili *et al.* (2002) reported an increase in fruit yield in brinjal with increment in the level of chemical nitrogen and maximum fruit yield of 180.40 q ha^{-1} was recorded at RDF. Combined application of organic and inorganic sources of plant nutrients recorded a maximum fruit yield of 54.32 t ha^{-1} in tomato as compared to sole application of both sources of plant nutrients (Harikrishna *et al*., 2002).

Combined application of NPK and sheep manure registered maximum fruit yield of 273.80 q ha^{-1} in capsicum cv. Nishat-1, which was higher than sole application (Magray *et al*., 2002). Application of goat manure enhanced the growth and growth related attributes in tomato plants (Umar and Jada, 2000). Conjugated application of sheep manure with urea to substitute 100 kg N in equal proportion (50:50) recorded significantly higher values for fruit number and fruit weight $plant^{-1}$ (11.0, 1000.7 g), respectively over that of sole application of sheep manure and 100 kg N through urea in brinjal (Jose *et al*., 1988). Combined application of 50 per cent sheep manure and 50 per cent RFD in capsicum cv. Nishat-1, recorded a fruit yield of 273.86 q ha^{-1} which was significantly superior to sole application of sheep manure and RFD (Narayan *et al*., 2004).

Substitution of plant nutrients in equal proportions through vermicompost + NPK and FYM + NPK recorded a maximum fruit yield of 51.55 t ha^{-1} and 58.65 t ha^{-1} in tomato as compared to the application of these sources of nutrients as sole (Rafi *et al*., 2002). Significant improvement in fruit yield of tomato was observed, when nitrogen was substituted in equal proportions through FYM and urea as compared to sole application of both sources (Reddy *et al*., 2002).

Sengupta *et al*. (2002) reported *Azospirillum* inoculation improved crop growth in tomato as compared to control. Combined application of microbial inoculations depicted beneficial effects on growth of Garlic (Chatoo *et al*., 2003). Further combined application of biofertilizers in tomato resulted in highest plant height, number of branches per plant, fruit weight and total yield per hectare as compared to the sole application of RFD (Premsekhar *et al*., 2009).

Erkossa *et al*. (2003), revealed that supplementing the N and P fertilizer in vegetables (tomato, potato) with organic sources of nutrients can improve the economic yield of the crops. Singh *et al*. (2005) observed that in hybrid tomato, combined application of organic and inorganic sources of plant nutrients produced significantly maximum plant height, number of branches, stem thickness, number of flower cluster plant^{-1}, fruit yield and number of pickings.

Singh *et al*. (2005) reported maximum fruit yield of tomato with the application of NPK @ 350 : 200 : 250 kg ha^{-1}.

Wani (2006) reported that combined application of RFD and poultry manure in proportion (50:50) registered maximum curd yield of (325.01 q

ha^{-1}) in cauliflower, besides registering improvement in quality attributes (Vitamin C content and protein content). Substitution of half N (50 kg) as poultry manure and half N (50 kg) as urea increased the fruit yield and yield related attribut characters significantly in brinjal (Jose *et al*., 1988). Application of poultry manure at different levels of combination exhibited better response in improving growth and growth related attributes in capsicum cv. Nishat-1 (Magray, 2002). Poultry manure exhibited superior performance in terms of yield and vigour in tomato, while sterilized poultry manure increased the yield in tomato by 25.57 per cent over that of nutrient solutions (Wang *et al*., 1992). Application of 40 per cent N through urea and 60 per cent through poultry manure in brinjal recorded highest fruit yield of 581 q ha^{-1} (Shelke *et al*., 2001).

Malik *et al*. (2009) found that integration of NPK @ 150 : 120 : 60 kg ha^{-1} and FYM @ 40 t ha^{-1} registered maximum fruit yield and other yield attributing characters in capsicum hybrid-SH-SP-5. Combined application of nitrogen through urea and FYM in equal proportions registered a fruit yield of 39.6 t ha^{-1} in brinjal, which was higher as compared to sole application of urea and FYM (Jose *et al*., 1988). Maximum number of fruit $plant^{-1}$, weight of fruit, total yield ha^{-1} in tomato were observed when treated with 100 per cent FYM + 50 per cent RFD (Manolikar *et al*., 2004).

2.2 Quality parameters

Singh *et al*. (1973) reported that poultry manure either alone or in combination with FYM in potato registered higher crude protein content of 1.46 and 1.40 per cent, respectively and both values were higher than control (1.2 %). Combined application of PM, VC and inorganic fertilizers in okra, recorded higher protein content as compared to sole application (Naidu *et al*., 2000). Application of poultry manure was found effective in enhancing crude protein content in tomato (Prabakarn and Pitchai, 2002).

Singh *et al*. (2000) reported that inorganic fertilizers registered a protein content of 2.14 per cent in fresh okra fruits which was higher than that recorded with treatments comprising of biofertilizers + dense organic manures and a vitamin C content of 13.61 mg 100 g^{-1} of fresh okra fruits was recorded in plots amended with inorganic fertilizers.

Singh *et al*. (2000) revealed that combined application of FYM and dense organic manure registered a protein content of 2.18 g 100 g^{-1} in fresh okra pods which was higher than 2.14 g 100 g^{-1} recorded with conventional method involving chemical fertilizers.

Combined application of vermicompost and NPK registered a maximum vitamin C content (25.53 mg 100 g^{-1}), maximum acidity (0.59 %) and TSS (5.87 ^{o}B) as compared to the sole application of NPK and vermicompost in tomato (Rafi *et al*., 2001). Quality attributes like total soluble solids and vitamin C content in cabbage got significantly increased due to combined application of vermicompost, digested organic supplements and 75 per cent RFD (Mahendran and Kumar, 2001).

Bhadoria *et al*. (2002) revealed that FYM either alone or in combination with microbial culture or vermicompost produced okra with better nutritional quality. Higher vitamin C content was found in vegetables grown with organic sources of plant nutrients as compared to those raised with inorganic fertilizers (Xu *et al*., 2003). Substitution of 75 kg N through FYM and 75 kg N through urea was found beneficial in increasing quality parameters of chilli (Malewar *et al*., 1998). Narayan *et al*. (2004) reported that integrated use of FYM and NPK exhibited improvement in vitamin C content as compared to sole application in capsicum cv. Nishat-1.

Sheep manure influenced the various quality parameters in vegetable crops. Sole application of sheep manure in capsicum cv. Nishat-1 registered a vitamin C content of 104.40 mg 100 g^{-1} which was higher than that (99.36 mg 100 g^{-1}) as recorded with RFD. Integration of 50 per cent sheep manure with 50 per cent RFD recorded a vitamin C content 118.80 mg 100 g^{-1}, which was 12.12, 7.10 per cent more than RFD and sole application of sheep manure, respectively (Naryan *et al*., 2004).

Kamili *et al*. (2002) reported maximum vitamin C content at RFD and increasing levels of chemical nitrogen resulted a significant increase in brinjal.

Prabhu *et al.* (2004) observed that increasing levels of nitrogen (100, 125, 150, 175 and 200 kg ha^{-1}) and phosphorus 150, 75 and 100 kg ha^{-1} recorded a slight increase in ascorbic acid content in brinjal hybrid COBH-1.

Singh *et al*. (2005) revealed significant improvement in ascorbic acid in tomato with increasing levels of nitrogen upto 150 kg ha^{-1}.

Guthane (2005) revealed that biofertilizers (rhizobium + PSB) along with 50 per cent RFD registered higher protein content in soybean as compared to RFD. However, Sengupta *et al*. (2002) observed that sole application of *Azospirillum* recorded slightly lower total soluble solids and vitamin C content as compared to 100 per cent N in tomato. Combined application of *Azospirillum* and NPK showed maximum TSS of tomato (Premsekhar *et al*., 2009).

Juroszek *et al.* (2007) recorded that the lycopene content of tomato was 12.0 mg 100 g^{-1} when organic sources of plant nutrients were used and this content was higher than (10.5 mg 100 g^{-1}) when inorganic sources of plant nutrients were used.

2.3 Physico-chemical properties of soil

Perumal *et al*. (2003) revealed increase in organic carbon content of soil with the application of vermicompost in carrot.

Shelke *et al*. (1999) reported maximum NPK content and highest organic carbon content in treatment combination where 40 per cent N was supplied through urea and 60 per cent N through poultry manure in brinjal.

Swain *et al*. (2003) reported that treatments receiving only inorganic fertilizers, exhibited drop in organic carbon content. Integrated use of bio-inoculants and fertilizers nitrogen had turned the soil acidic. However, the decrease in pH was marginal in the treatments receiving bio-inoculants.

Combined application of *Azospirillum*, phosphobacteria and 50 per cent RFD showed an increase in pH and organic carbon content as compared to 100 per cent RFD (Gogoi *et al*., 2004).

Hori *et al*. (2002) reported poultry manure application resulted inadequate pH, increased electrical conductivity.

Renuka and Sankar (2001) observed that organic nutrient application kept the pH near neutral. Bhattacharya *et al*. (2000) reported increase in soil organic carbon content with FYM application alone as well as with integration of FYM and NPK.

Ray *et al*. (2005) registered a decrease in soil pH and organic carbon content due to inorganic fertilizer application in okra. Continuous application of chemical fertilizers recorded a significant decrease in soil pH, nitrogen though urea had the most deleterious effect on soil pH. Organic carbon content exhibited 60 per cent increase over initial when 100 per cent chemical fertilizer was used in conjugation with FYM (Subehia *et al*., 2005).

Application of organic sources of plant nutrients increased availability of N, P, K Ca, Mg and S in the soil (Wong *et al*., 1999).

Umar and Jada (2000) reported that goat manure application in tomato enhanced the nutrient supply in the soil.

Poultry manure application resulted in significant buildup of available and total phosphorus in the soil (Kaistha *et al*., 1997). Reddy and Reddy (1999) reported that poultry manure application along with chemical fertilizers significantly influenced the availability of micro-nutrients in the soil.

Perumal *et al*. (2003) reported that application of vermi-compost increased the availability of nutrients in the soil.

Dademal and Dongale (2004) reported that the status of available N,P and K content of soil was significantly improved with the application of chemical fertilizers in okra as compared to no fertilizer application. Application of inorganic fertilizer in okra registered a drop in available nitrogen and potassium but the available phosphorus was slightly increased (Ray *et al*., 2005).

2.4 Economics

Verghese (1996) revealed that maximum net returns of Rs. 48035.00 with a cost benefit ratio of 1:4.72 was recorded in cabbage with treatment combinations of 50 per cent NPK + 5 t poultry manure ha^{-1}. The maximum marketable fruit yield of brinjal marketable fruit yield of brinjal (392.5 q ha^{-1}) was recorded with a cost benefit ratio of 1:1.93 with the application of 75 kg N + 10 t poultry manure + *Azospirrllum* (Jhon, 1997). Net returns in organically produced vegetables were higher as the produced received premium prices in the market (Bhardwaj *et al*., 2000). Thronsbug *et al*. (2000) revealed that 7 per cent increase in total production and marketing cost of tomato growers due to use of organic wastes and 50 per cent replacement of inorganic fertilizers.

CHAPTER – 3

MATERIALS AND METHODS

The present investigation, “Response of Shalimar Tomato Hybrid-1 to organic and inorganic sources of Plant Nutrients”, was carried out during *kharif* 2009 and *kharif* 2010 at same locations at Experiment Farm, Division of Olericulture, SKUAST-K, Shalimar. The geographical situation of farm lies at 35.1^{o} north latitude and 74.89^{o} east longitude at an elevation of 1587 meters above sea level. The climate is temperate and mean rainfall and relative humidity during summer 2009 was 1.46 mm and 65.64 per cent, respectively. While the mean rainfall and relative humidity during 2010 was 3.61 mm and 71.63 per cent, respectively. The mean monthly meteorological data at Shalimar during the period of experimentation was recorded at agro-meteorological observation of SKUAST-K, Shalimar Campus. The details of the material used and the methods adopted are given below :

3.1 Experimental materials

The organic manures viz., Farm Yard Manure (FYM), Sheep Manure (SM), Poultry Manure (PM), Vermi Compost (VM), Biofertilizers, chemical fertilizers (urea, diammonium phosphate, muriate of potash) were used as source of plant nutrients. Organic manure and chemical fertilizers were obtained from authorised sources, the seed of Shalimar Tomato Hybrid-1 was provided by Division of Olericulture.

3.2 Experimental methods

3.2.1 Treatment details

Treatments	:	12
Replications	:	03
Plot size	:	3 x 2.25 m = 6.75 m^2
Spacing	:	60 x 45 cm
No. of plants $plot^{-1}$	:	20
Hybrid	:	Shalimar Tomato Hybrid-1
Number of location	:	01
Date of sowings *Kharif* 2009 *Kharif* 2010	:	3^{rd} April
Date of transplanting *Kharif* 2009 *Kharif* 2010	:	10^{th} May
Design	:	Randomised Bock Design (RBD)

3.2.2 Treatment details

Treatment		Symbol
Recommended Fertilizer Dose (RFD)	190 N:150 P_2O_5:110 K_2O kg ha^{-1}	T_1
Farm Yard Manure (FYM)	38 t ha^{-1}	T_2
Sheep Manure	32 t ha^{-1}	T_3
Poultry Manure	7 t ha^{-1}	T_4
Vermicompost	14 t ha^{-1}	T_5
Biofertilizer (*Azospirillium* + *Phosphobacteria*)	2.5 kg ha^{-1}	T_6
FYM 50% + RFD 50%	19 t + 95 N: 75 P_2O_5: 55 K_2O kg ha^{-1}	T_7
SM 50% + RFD 50%	16 t + 95 N: 75 P_2O_5: 55 K_2O kg ha^{-1}	T_8
PM 50% + RFD 50%	3.5 t + 95 N: 75 P_2O_5: 55 K_2O kg ha^{-1}	T_9
VC 50% + RFD 50%	7 t + 95 N: 75 P_2O_5: 55 K_2O kg ha^{-1}	T_{10}
Biofertilizer + RFD 50%	2.5 kg Soil inoculant + 95 N: 75 P_2O_5: 55 K_2O kg ha^{-1}	T_{11}
Control	No organic manure or chemical fertilizers	T_{12}

3.3 Experimental site and preparatory tillage

The site of the experiment at Shalimar field was well levelled, with uniform soil fertility, good drainage and better water holding capacity, land was prepared by ploughing, clod breaking and was brought to fine tilth.

Thirty six plot of 3 x 2.25 m size were prepared as per layout specification to accommodate 20 plant per plot separating each plot from the adjoining plot by 25 cm wide small earthen bunds (Fig. 1). The field was also provided with one main and two sub-irrigation channels to facilitate plot to plot irrigation.

3.4 Application of manures and fertilizers

Whole of the organic manures (FYM, SM, PM, VC and biofertilizers) were applied as a basal dose one week prior to transplanting to the specific plot as per the technical programme and mixed well with the soil just before transplanting. The entire dose of phosphorus and potassium along with half dose of nitrogen was given as a basal dose and thoroughly mixed with soil. The remaining half nitrogen was top-dressed 30 days after transplanting.

The source of N, P and K were urea (46 % N), DAP (46% P_2O_5 and 18% N) and MOP (60% K_2O). The manures FYM, SM, PM, VC, biofertilizers were used.

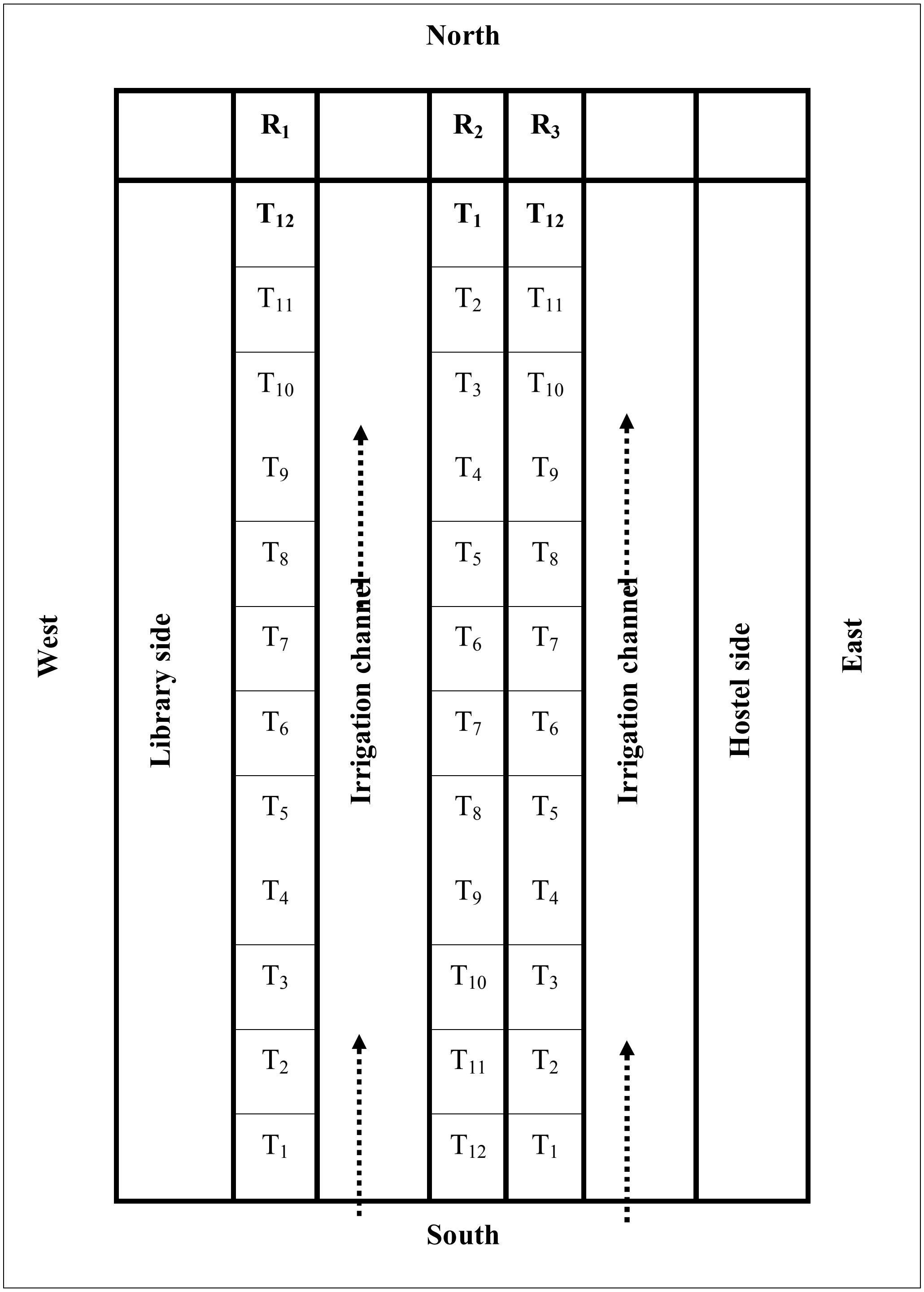

Fig. 1 : Layout of experimental field

3.5 Sowing of seed and transplanting

The seeds were sown in lines in the raised nursery bed in the first week of April and were covered with ash. In order to ensure better germination the beds were covered with dry grass till the germination was complete. Light watering was done in the morning hours with the help of a rose cane. Proper care and required cultural operations such as weeding, irrigation etc. were taken up during the entire period of nursery raising. The nursery beds were watered prior to lifting of seedlings. Vigorous and healthy uniform size seedling were transplanted in well prepared plots on 10^{th} of May, 2009 and on 10^{th} of May, 2010 at Shalimar in the evening just to prevent excessive transpiration, the plant spacing of 60 cm between rows and 45 cm between plants was maintained. The light irrigation with rose cane was given immediately after transplanting and the plot wise irrigation was given through channels as and when required. In order to maintain the requisite population, gap filling was also done after one week after transplanting.

3.6 Harvesting

Harvesting of fruit was started from last week of July and continued upto last week of October. Picking of fruits was done at marketable stage at an interval of ten days and a total of eight pickings were made during cropping period.

3.7 Observations recorded

Observations on different characters were recorded on ten randomly selected plants from each treatment in every replication. Observation on fruit characters were recorded from fruits of 3rd picking onwards. While plant height and number of branches were recorded at final harvest.

Data on different characters from each treatment was recorded and their average was worked out for statistical analysis.

3.8 Observation on growth and yield related parameters of Shalimar Tomato Hybrid-1.

The following observations with respect to growth and yield parameters were recorded :

3.8.1 Plant height (cm)

Plant height was measured in centimetres with the help of a meter scale from ground level to the tip of the plant from ten randomly selected plants at the time of final picking and their average work out.

3.8.2 Number of branches plant^{-1}

At the final harvest stage, the number of branches from 10 randomly selected plants were counted and the mean was calculated.

3.8.3 Number of fruits plant^{-1}

The number of fruits from each picking were counted and finally added to get the total number of fruits and average from ten plants was worked out to get the average number of fruits plant^{-1}.

3.8.4 Fruit diameter (cm)

Fruit diameter was measured in centimetre from the fruits. In was measured for the middle portion of the fruit with the help of veriner calliper and average fruit diameter worked out.

3.8.5 Average fruit weight (g)

Total weights of fruits obtained from each picking was pooled and divided by total number of fruits to work out an average fruit weight.

3.8.6 Fruit yield ha^{-1} (q)

The total weight of fruits obtained from each picking from representative plants was pooled and average yield plant^{-1} (g) calculated. The fruit yield plant^{-1} was then multiplied by the number of plants (20) in a plot to get the fruit yield plot^{-1} (kg) which was then converted into fruit yield ha^{-1} (q).

3.9 Observation on quality related parameters of Shalimar Tomato Hybrid-1

3.9.1 Vitamin C content (mg 100 g^{-1})

Ascorbic acid, generally known as vitamin C is present in all fresh vegetables and fruits. The fresh ripe fruits preferably of uniform size from representative plants were picked and cut into small pieces. 100 g of chopped fresh ripe fruits from each plot/treatment were then used for estimation of vitamin C content in the laboratory following 2, 6, dichlorophenol indophenol visual titration method (A.O.A.C., 1975) and expressed in milligrams 100 g^{-1} of fresh weight.

3.9.2 TSS (^{o}Brix)

TSS of fresh ripe fruits was measured with the help of hand refractromenter. The refractometer was washed after each use.

3.9.3 Lycopene content (mg 100 g^{-1})

The lycopene content of the fresh ripe fruit was measured by using a spectrophotometer (Rangana, 1986).

3.9.4 Protein content (%)

The protein content was calculated by multiplying a factor 6.25 with total nitrogen content in fruits. Total nitrogen content in fruits was determined by Kjeldahls method as outlined by Tandon (1993).

3.9.5 Acidity (%)

The titrable acidity was determined following the procedure of Rangana (1986).

3.10 Soil nutrient analysis

Representative soil samples of the experimental sites before the start of experiment as well as after the harvest of each crop from each treatment were taken from a depth of 0-15 cm and analysed for OC, pH, EC, N, P and K using standard procedure. The initial status of experimental site with respect to above characteristics is given in Table-1.

Table-1 : Initial status of experimental fields with respect to available N, P, K, OC, Soil pH and EC

Character	Value	Range
OC (%)	1.13	High
pH	7.21	Near neutral
EC (dsm^{-1})	0.090	Normal
Available N (kg ha^{-1})	246	Low
Available P_2O_5 (kg ha^{-1})	20.18	Medium
Available K_2O (kg ha^{-1})	191.20	Medium

3.11 Chemical characteristics

3.11.1 Organic carbon (%)

The organic carbon content was estimated by Walkley and Black's method (1934).

3.11.2 pH

The pH of the soil samples was determined by digital pH meter on 1:2.5 ratio of soil water suspension (Jackson, 1973).

3.11.3 Electrical conductivity (dsm^{-1})

Electrical conductivity was estimated by solobridge conductivity meter (Jackson, 1973).

3.11.4 Available nitrogen (kg ha^{-1})

Available nitrogen was determined by alkaline per magnate method as described by Subbiah and Asija (1956).

3.11.5 Available phosphorus (kg ha^{-1})

Available phosphorus was determined by Olsen method (1954) as described by Jackson (1973).

3.11.6 Available potassium (kg ha^{-1})

Available potassium was determined by extracting with neutral normal ammonium acetate method (Merwin and Peech, 1950) using flame photometer as outlined by Jackson (1973).

3.12 Economics of production

The economics of different cultural practices, inputs and returns for Shalimar Tomato Hybrid-1 under each treatment was worked out under Kashmir conditions to find the most effective and economical treatment. The average sale rate of the marketable Shalimar Tomato Hybrid-1 during the growing season was Rs. 6 per kg for inorganic and Rs. 10 per kg for organics.

3.13. Statistical analysis

In order to test the significance of results, the experimental data was subjected to statistical analysis as per the standard statistical procedure given by Gomez and Gomez (1984). Levels of significance used for 'F' and 'T' tests were P = 0.05 as given by Fisher (1970).

CHAPTER – 4

EXPERIMENTAL FINDINGS

The experiment was carried out at experimental Farm of the Division of Olericulture, SKUAST-K, Shalimar during *kharif* 2009 and 2010 using Shalimar Tomato Hybrid-1.

A number of observations were recorded at different stages of plant growth. The data collected was subjected to statistical analysis for proper interpretation of results. The results obtained from the present investigation are presented under the following heads :

4.1 Influence of organic and inorganic sources of plant nutrients on growth attributes of Shalimar Tomato Hybrid-1

4.1.1 Plant height (cm)

Perusal of Table-2 revealed significant effect of various treatments on plant height. Integration of organic with inorganic sources of plant nutrients proved superior over sole applications.

Among sole application of organic sources, treatment T_4 (poultry manure 7 t ha^{-1}) recorded a plant height of 99.00 and 94.00 cm during *kharif* 2009 and *kharif* 2010, respectively and was significantly superior to treatment T_2 (FYM 38 t ha^{-1}), T_3 (sheep manure 32 t ha^{-1}), T_6 (biofertilizers

Table-2 : Influence of organic and inorganic sources of plant nutrients on plant height (cm) of Shalimar Tomato Hybrid-1

Treatments		Kharif		Pooled Mean
		2009	2010	
T_1	Recommended Fertilizer Dose (RFD) 190 N:150 P_2O_5:110 K_2O kg ha^{-1}	125.03	118.50	**121.76**
T_2	Farm Yard Manure (FYM) 38 t ha^{-1}	87.50	83.33	**85.41**
T_3	Sheep Manure (SM) 32 t ha^{-1}	93.73	89.42	**91.57**
T_4	Poultry Manure (PM) 7 t ha^{-1}	99.00	94.00	**96.50**
T_5	Vermicompost (VC) 14 t ha^{-1}	97.50	92.52	**95.01**
T_6	Biofertilizers (*Azospirillium* + *Phosphobacter*) 2.5 kg ha^{-1}	78.40	76.63	**77.51**
T_7	FYM 50 % + RFD 50 % 19 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	108.57	105.00	**106.78**
T_8	SM 50% + RFD 50 % 16 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	122.43	117.28	**119.85**
T_9	PM 50 % + RFD 50 % 3.5 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	133.67	126.45	**130.06**
T_{10}	VC 50 % + RFD 50 % 7 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	127.69	120.51	**124.10**
T_{11}	Biofertilizer + RFD 50 % 2.5 kg Soil inoculant + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	100.00	95.93	**97.96**
T_{12}	Control (No organic manure or chemical fertilizers)	70.33	68.70	**69.51**
$C.D_{(p \leq 0.05)}$		**2.73**	**2.38**	**1.63**

2.5 kg ha^{-1}) and T_{12} (control) but exhibited significantly lower values than T_1 (100% RFD). Treatment T_4 exhibited at par results with T_5 (vermicompost 14 t ha^{-1}) during both seasons. Pooled analysis revealed that treatment T_4 recorded a plant height of 96.50 cm which was significantly superior to T_2, T_3, T_6 and T_{12} but exhibited at par results with T_5 (vermicompost 14 t ha^{-1}) recording a plant height of 95.01 cm. However, T_4 recorded significantly lower plant height than T_1 (100% RFD) recording a plant height of 121.76 cm (Table-2).

Integration of organic sources with inorganic sources of plant nutrients in equal proportion 50:50 exhibited an increase in plant height. Treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) recorded a plant height of 133.67 and 126.45 cm during *kharif*-2009 and *kharif*-2010, respectively, which was significantly superior to all treatment. Treatment T_{10} (7 t VC + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) recorded a plant height of 127.69 and 120.51 cm during *kharif*-2009 and *kharif*-2010, respectively and was found significantly superior to all treatments except. T_9. However, it exhibited at par results with T_1 recording a plant height of 125.03 and 118.50 cm during *kharif*-2009 and *kharif*-2010, respectively. Pooled analysis revealed the significance of T_9 over rest of the treatments recording a plant height of 130.06 cm. Treatment T_{10} recorded a plant height of

124.10 cm, which was significantly superior to all treatment except T_9 (Table-2).

4.1.2 Number of branches plant^{-1}

Perusal of the Table-3 revealed the significance of various treatments on number of branches plant^{-1}. Integration of organic and inorganic sources of plant nutrients proved superior to sole applications.

Among sole application of organic sources treatment T_4 (poultry manure 7 t ha^{-1}) recorded maximum number of branches 8.69 and 8.30 plant^{-1} during *kharif*-2009 and *kharif*-2010, respectively and was found significantly superior to treatment T_2, T_3, T_6 and T_{12} during both seasons. Treatment T_4 exhibited at par results with treatment T_5 (vermicompost 7 t ha^{-1}) during both the seasons. However, exhibited at par results with treatment T_3 (sheep manure 32 t ha^{-1}) during *kharif*-2010. Pooled analysis revealed that treatment T_4, recorded 8.49 branches plant^{-1} and was significantly superior to T_2, T_3, T_6 and T_{12} but exhibited at par results with T_5 (8.39 branches plant^{-1}). However, T_4 registered significantly lower values than T_1 (100% RFD) recording 10.63 branches plant^{-1}.

Integration of organic sources with inorganic sources of plant nutrients in equal proportion (50:50) exhibited an increase in number of branches plant^{-1}. Treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1})

Table-3 : Influence of organic and inorganic sources of plant nutrients on number of branches plant^{-1} of Shalimar Tomato Hybrid-1

Treatments		Kharif		Pooled Mean
		2009	2010	
T_1	Recommended Fertilizer Dose (RFD) 190 N:150 P_2O_5:110 K_2O kg ha^{-1}	10.78	10.48	**10.63**
T_2	Farm Yard Manure (FYM) 38 t ha^{-1}	7.70	7.35	**7.52**
T_3	Sheep Manure (SM) 32 t ha^{-1}	8.23	7.91	**8.07**
T_4	Poultry Manure (PM) 7 t ha^{-1}	8.69	8.30	**8.49**
T_5	Vermicompost (VC) 14 t ha^{-1}	8.63	8.20	**8.39**
T_6	Biofertilizers (*Azospirillium* + *Phosphobacter*) 2.5 kg ha^{-1}	7.53	7.40	**7.46**
T_7	FYM 50 % + RFD 50 % 19 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	9.62	9.20	**9.41**
T_8	SM 50% + RFD 50 % 16 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	10.72	10.27	**10.49**
T_9	PM 50 % + RFD 50 % 3.5 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	11.73	11.20	**11.46**
T_{10}	VC 50 % + RFD 50 % 7 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	11.23	10.69	**10.96**
T_{11}	Biofertilizer + RFD 50 % 2.5 kg Soil inoculant + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	9.43	9.24	**9.33**
T_{12}	Control (No organic manure or chemical fertilizers)	5.74	5.65	**5.69**
C.D$_{(p\leq0.05)}$		**0.12**	**0.73**	**0.12**

recorded 11.73 and 11.20 number of branches plant^{-1} during *kharif*-2009 and *kharif*-2010, respectively which was significantly superior to all treatments. However, during *kharif*-2010 T_9 exhibited at par results with T_1 and T_{10} (Table-3).

Treatment T_{10} (7 t VC + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) registered 11.23 and 10.69 number of branches plant^{-1} during *kharif*-2009 and *kharif*-2010, respectively. However, during *kharif*-2010, T_{10} exhibited at par results with T_1 and T_8 (Table-3). Pooled analysis revealed that T_9 registered maximum number of branches 11.46 plant^{-1} which was significantly superior to all treatments. Treatment T_{10} registered 10.96 number of branches plant^{-1} which was significantly superior to all treatments except T_9 (Table-3).

4.2.1 Number of fruits plant^{-1}

Perusal of Table-4 indicate significant influence of various treatments on number of fruits plant^{-1}. Integration of organic sources with inorganic sources of plant nutrients exhibited an increase over sole application.

Among sole application of organic sources, treatment T_4 (poultry manure 7 t ha^{-1}) recorded maximum number of fruits 48.67 and 45.60 plant^{-1} during *kharif*-2009 and *kharif*-2010 respectively and was found

Table-4 : Influence of organic and inorganic sources of plant nutrients on number of fruits plant^{-1} of Shalimar Tomato Hybrid-1

Treatments		Kharif		Pooled Mean
		2009	2010	
T_1	Recommended Fertilizer Dose (RFD) 190 N:150 P_2O_5:110 K_2O kg ha^{-1}	62.25	56.25	**59.25**
T_2	Farm Yard Manure (FYM) 38 t ha^{-1}	43.32	39.33	**41.32**
T_3	Sheep Manure (SM) 32 t ha^{-1}	46.96	42.40	**44.68**
T_4	Poultry Manure (PM) 7 t ha^{-1}	48.67	45.60	**47.13**
T_5	Vermicompost (VC) 14 t ha^{-1}	48.17	44.58	**46.37**
T_6	Biofertilizers (*Azospirillium* + *Phosphobacter*) 2.5 kg ha^{-1}	38.41	37.23	**37.82**
T_7	FYM 50 % + RFD 50 % 19 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	54.47	50.32	**52.39**
T_8	SM 50% + RFD 50 % 16 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	59.86	55.42	**57.64**
T_9	PM 50 % + RFD 50 % 3.5 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	66.27	58.35	**62.31**
T_{10}	VC 50 % + RFD 50 % 7 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	62.60	57.32	**59.96**
T_{11}	Biofertilizer + RFD 50 % 2.5 kg Soil inoculant + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	47.50	46.51	**47.00**
T_{12}	Control (No organic manure or chemical fertilizers)	32.08	27.42	**29.75**
$C.D_{(p\leq 0.05)}$		**1.98**	**1.90**	**1.89**

significantly superior to T_2, T_6 and T_{12} during *kharif*-2009 but exhibited at par results with T_3 and T_5. However, during *kharif*-2010, treatment T_4 proved significantly superior to T_3 (sheep manure 32 t ha^{-1}).

Treatment T_1 (100% RFD) registered significantly higher number of fruits 62.25 and 56.25 $plant^{-1}$ during *kharif*-2009 and 2010, respectively over sole application of organics (Table-4). Pooled analysis indicate that treatment T_4 registered higher number of fruits 47.13 $plant^{-1}$ and was significantly superior to T_2, T_3, T_6 and T_{12} but exhibited at par results with T_5. However, T_4 recorded significantly lower number of fruits $plant^{-1}$ than T_1 (100 % RFD) recording 59.25 fruits $plant^{-1}$ (Table-4).

Combined application of organic sources of plant nutrients with inorganic ones in equal proportion (50:50) exhibited an increase in number of fruits $plant^{-1}$. Treatment T_9 registered maximum number of fruits 66.27 and 58.35 $plant^{-1}$ during *kharif*-2009 and *kharif*-2010, respectively and was found significantly superior to all treatment but exhibited at par results with T_{10} during *kharif*-2010 (Table-4). Treatment T_{10} (7 t VC + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) recorded a fruit number of 62.60 and 57.32 $plant^{-1}$ during *kharif*-2009 and *kharif*-2010, respectively. During *kharif*-2010, it exhibited significant superiority over rest of the treatments except T_9, but registered at par results with T_1. However, during *kharif*-2010, it registered at par results with T_8 (Table-4). Pooled analysis indicate that T_9 recorded a fruit number of 62.31 plant^{-1}, which was significantly superior to all treatments. Treatment T_{10} recorded a fruit number of 59.96 plant^{-1} which was significantly superior to all treatments except T_9 but exhibited at par results with T_1 recoding a fruit number of 59.25 plant^{-1}.

4.2.2 Average fruit diameter (cm)

Perusal of Table-5 revealed significant influence of various treatments on average fruit diameter. Integration of organic sources of plant nutrients with inorganic sources exhibited an improvement over sole applications.

Among sole application of organic sources, treatment T_4 (poultry manure 7 t ha^{-1}) recorded an average fruit diameter of 4.70 and 4.49 cm during *kharif*-2009 and *kharif*-2010, respectively and was found significantly superior to T_2, T_3, T_5, T_6 and T_{12} except T_1 (100% RFD) recording an average fruit diameter of 5.12 and 4.78 cm during both the seasons (Table-5). Pooled analysis indicate that treatment T_4 registered an average fruit diameter of 4.59 cm which was significantly superior to T_2, T_3, T_5, T_6 and T_{12} except T_1 (100% RFD) which recorded an average fruit diameter of 4.95 cm (Table-5).

Table-5 : Influence of organic and inorganic sources of plant nutrients on average fruit diameter (cm) of Shalimar Tomato Hybrid-1

Treatments		Kharif 2009	Kharif 2010	Pooled Mean
T_1	Recommended Fertilizer Dose (RFD) 190 N:150 P_2O_5:110 K_2O kg ha^{-1}	5.12	4.78	**4.95**
T_2	Farm Yard Manure (FYM) 38 t ha^{-1}	4.36	4.30	**4.33**
T_3	Sheep Manure (SM) 32 t ha^{-1}	4.52	4.41	**4.46**
T_4	Poultry Manure (PM) 7 t ha^{-1}	4.70	4.49	**4.59**
T_5	Vermicompost (VC) 14 t ha^{-1}	4.56	4.41	**4.48**
T_6	Biofertilizers (*Azospirillium* + *Phosphobacter*) 2.5 kg ha^{-1}	4.00	3.76	**3.88**
T_7	FYM 50 % + RFD 50 % 19 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	4.72	4.51	**4.61**
T_8	SM 50% + RFD 50 % 16 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	4.81	4.77	**4.79**
T_9	PM 50 % + RFD 50 % 3.5 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	5.47	5.04	**5.25**
T_{10}	VC 50 % + RFD 50 % 7 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	4.96	4.96	**4.96**
T_{11}	Biofertilizer + RFD 50 % 2.5 kg Soil inoculant + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	4.63	4.50	**4.56**
T_{12}	Control (No organic manure or chemical fertilizers)	3.26	3.06	**3.16**
$C.D_{(p \leq 0.05)}$		**0.04**	**0.02**	**0.03**

Integration of organic sources of plant nutrients with inorganic ones in equal proportions (50:50) exhibited an increase in average fruit diameter.

Among integrations, treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) registered an average fruit diameter of 5.47 and 5.04 cm during *kharif*-2009 and *kharif*-2010, respectively and exhibited significant superiority over all treatments. Treatment T_{10} (7 t VC + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) recorded an average fruit diameter of 4.96 and 4.96 cm during *kharif*-2009 and *kharif*-2010, respectively and was found significantly superior to all treatment except T_9. Pooled analysis revealed that treatment T_9 recorded an average fruit diameter of 5.25 cm which was significantly superior to all treatments. Treatment T_{10} registered an average fruit diameter of 4.96 cm, and was found significantly superior to all treatments except T_9 but exhibited at par results with T_1 recording an average fruit diameter of 4.95 cm (Table-5)

4.2.3 Average fruit weight (g)

Perusal of Table-6, revealed significant effect of various treatments on average fruit weight. Conjugation of organic sources of plant nutrients with inorganic sources of plant nutrients proved superior over sole applications.

Table-6 : **Influence of organic and inorganic sources of plant nutrients on average fruit weight (g) of Shalimar Tomato Hybrid-1**

Treatments		Kharif		Pooled Mean
		2009	2010	
T_1	Recommended Fertilizer Dose (RFD) 190 N:150 P_2O_5:110 K_2O kg ha^{-1}	60.34	56.09	**58.21**
T_2	Farm Yard Manure (FYM) 38 t ha^{-1}	51.35	50.60	**50.97**
T_3	Sheep Manure (SM) 32 t ha^{-1}	53.21	51.12	**52.16**
T_4	Poultry Manure (PM) 7 t ha^{-1}	55.31	52.41	**53.86**
T_5	Vermicompost (VC) 14 t ha^{-1}	53.67	51.23	**52.45**
T_6	Biofertilizers (*Azospirillium* + *Phosphobacter*) 2.5 kg ha^{-1}	45.35	42.71	**44.03**
T_7	FYM 50 % + RFD 50 % 19 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	53.68	51.08	**52.38**
T_8	SM 50% + RFD 50 % 16 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	54.69	52.99	**53.84**
T_9	PM 50 % + RFD 50 % 3.5 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	62.22	57.29	**59.75**
T_{10}	VC 50 % + RFD 50 % 7 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	56.36	55.65	**56.00**
T_{11}	Biofertilizer + RFD 50 % 2.5 kg Soil inoculant + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	52.58	51.65	**52.11**
T_{12}	Control (No organic manure or chemical fertilizers)	36.67	34.02	**35.34**
$C.D_{(p\leq0.05)}$		**3.99**	**3.64**	**2.68**

Among sole application of organic sources, treatment T_4 (poultry manure 7 ha^{-1}) recorded average fruit weight of 55.31 and 52.41 g during *kharif*-2009 and *kharif*-2010 respectively and was found significantly superior to treatment T_6 and T_{12}, but exhibited at par results with treatment T_2, T_3, T_5 during both seasons. T_4 registered significantly lower values as compared to treatment T_1 recording an average fruit weight 60.34 and 56.09 g during *kharif*-2009 and 2010, respectively. Pooled analysis revealed that treatment T_4 recorded an average fruit weight of 53.86 g which was significantly superior to T_2, T_6 and T_{12} (control) but exhibited at par results with T_3 and T_5. However, T_4 recorded significantly lower fruit weight than T_1 recording an average fruit weight of 58.21 g (Table-6).

Among integration of organic sources of plant nutrients with inorganic ones, treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) registered an average fruit weight of 62.22 g, which was significantly superior to all treatments but exhibited at par results with T_1 recording a fruit weight of 60.34 g during *kharif*-2009. However, during *kharif*-2010, T_9 recorded an average fruit weight of 57.29 g which was significantly superior to all treatments except T_1 and T_{10} where it exhibited at par results. During *kharif*-2009, treatment T_{10} (7 t VC + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) recorded an average fruit weight of 56.36 g and was found significantly superior to T_2, T_6, T_{11} and T_{12} but exhibited at par results with rest of the treatments except T_9. However, during *kharif*-2010, T_{10} recorded an average fruit weight of 55.65 g which was significantly superior to T_2, T_3, T_5, T_6, T_7, T_{11} and T_{12} but exhibited at par results with rest of the treatments (Table-6).

Pooled analysis revealed the significance of T_9 over rest of treatments recording an average fruit weight of 59.75g which was significantly superior to all other treatments but exhibited at par results with T_1 recording a fruit weight of 58.21 g. Treatment T_{10} recorded a fruit weight of 56.00 g which was found significantly superior to all other treatments except T_1 and T_9. But exhibited statistically at par results with T_4 and T_8 (Table-6).

4.2.4 Fruit yield (q ha^{-1})

Perusal of Table-7 revealed the significance of various treatments on fruit yield ha^{-1}. Integration of organic and inorganic sources of plant nutrients proved superior to sole applications.

Among sole application of organic sources, treatment T_4 (poultry manure 7 t ha^{-1}) recorded a fruit yield of 392.38 and 383.73 (q ha^{-1}) during *kharif*-2009 and *kharif*-2010, respectively and was found significantly superior to T_2, T_3, T_5, T_6 and T_{12} during both the seasons. However,

Table-7 : Influence of organic and inorganic sources of plant nutrients on fruit yield ha^{-1} (q) of Shalimar Tomato Hybrid-1

Treatments		Kharif		Pooled Mean
		2009	2010	
T_1	Recommended Fertilizer Dose (RFD) 190 N:150 P_2O_5:110 K_2O kg ha^{-1}	531.41	518.20	**524.80**
T_2	Farm Yard Manure (FYM) 38 t ha^{-1}	345.40	310.33	**327.86**
T_3	Sheep Manure (SM) 32 t ha^{-1}	371.68	362.91	**367.29**
T_4	Poultry Manure (PM) 7 t ha^{-1}	392.38	383.73	**388.05**
T_5	Vermicompost (VC) 14 t ha^{-1}	387.89	378.22	**383.05**
T_6	Biofertilizers (*Azospirillium* + *Phosphobacter*) 2.5 kg ha^{-1}	300.90	297.30	**299.10**
T_7	FYM 50 % + RFD 50 % 19 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	448.67	403.44	**426.05**
T_8	SM 50% + RFD 50 % 16 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	502.16	488.44	**495.30**
T_9	PM 50 % + RFD 50 % 3.5 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	548.71	522.12	**533.41**
T_{10}	VC 50 % + RFD 50 % 7 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	526.23	514.03	**520.13**
T_{11}	Biofertilizer + RFD 50 % 2.5 kg Soil inoculant + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	390.80	386.16	**388.48**
T_{12}	Control (No organic manure or chemical fertilizers)	250.26	248.26	**249.26**
C.D$_{(p\leq0.05)}$		**4.48**	**2.07**	**2.93**

treatment T_4 exhibited significantly lower values as compared to T_1 (100% RFD) recording a fruit yield of 531.41 and 518.20 q ha^{-1} during both the seasons, respectively (Table-7).

Pooled analysis revealed that treatment T_4, recorded a fruit yield of 388.05 q ha^{-1} which was significantly superior to T_2, T_3, T_5, T_6 and T_{12} but registered significantly lower fruit yield as compared to treatment T_1 (100% RFD) recording a fruit yield of 524.80 q ha^{-1}.

Integration of organic sources with inorganic sources of plant nutrients in equal proportions (50:50) exhibited an increase in fruit yield. Treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) registered a fruit yield of 548.71 and 522.12 q ha^{-1} during *kharif* 2009 and *kharif*-2010 respectively and was found significantly superior to all other treatments during both seasons. Treatment T_{10} (7 t VC + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) registered a fruit yield of 526.23 and 514.03 q ha^{-1} during *kharif*-2009 and *kharif*-2010, respectively and was found significantly superior to all treatments except T_9 and T_1.

Pooled analysis revealed that T_9 registered a fruit yield of 533.41 q ha^{-1} which was significantly superior to all treatments. Treatment T_{10} registered 520.13 fruit yield q ha^{-1} and was found significantly superior to all treatments except T_1 and T_9 (Table-7).

4.3 Influence of organic and inorganic sources of plant nutrients on quality attributes of Shalimar Tomato Hybrid-I

4.3.1 Vitamin C content (mg/100 g)

Perusal of Table-8 indicated significant influence of various treatments on vitamin C content (mg 100 g^{-1}). Integration of organic sources with inorganic sources of plant nutrients exhibited an increase over sole applications.

Among sole application of organic sources, treatment T_4 (PM 7t ha^{-1}) recorded maximum vitamin C content of 25.13 and 24.96 mg 100 g^{-1} during *kharif* 2009 and *kharif* 2010, respectively and was found significantly superior to treatment T_1, T_6 and T_{12} but was statistically as par with treatment T_2, T_3 and T_5. Pooled analysis also revealed that treatment T_4 registered maximum vitamin C content of 25.04 mg 100 g^{-1} and was found significantly superior to T_1, T_6 and T_{12} but exhibited at par results with T_2, T_3 and T_5 (Table-8).

Combined application of organic sources of plant nutrients with inorganic ones in equal proportion (50:50) exhibited an increase in vitamin C content of tomato fruit. Treatment T_9 registered maximum vitamin C content of 25.67 and 25.04 mg 100 g^{-1} during *kharif* 2009 and *kharif* 2010, respectively and was found significantly superior to treatment T_1, T_6 and T_{12} but exhibited at par results with rest of treatments during both seasons.

Table-8 : **Influence of organic and inorganic sources of plant nutrients on vitamin C content ($mg/100^{-1}g$) of Shalimar Tomato Hybrid-1**

Treatments		Kharif		Pooled Mean
		2009	2010	
T_1	Recommended Fertilizer Dose (RFD) 190 N:150 P_2O_5:110 K_2O kg ha^{-1}	23.45	23.07	**23.26**
T_2	Farm Yard Manure (FYM) 38 t ha^{-1}	24.75	24.35	**24.55**
T_3	Sheep Manure (SM) 32 t ha^{-1}	25.04	24.36	**24.70**
T_4	Poultry Manure (PM) 7 t ha^{-1}	25.13	24.96	**25.04**
T_5	Vermicompost (VC) 14 t ha^{-1}	25.07	24.93	**25.00**
T_6	Biofertilizers (*Azospirillium* + *Phosphobacter*) 2.5 kg ha^{-1}	23.51	23.09	**23.30**
T_7	FYM 50 % + RFD 50 % 19 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	25.00	24.29	**24.64**
T_8	SM 50% + RFD 50 % 16 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	25.06	24.86	**24.96**
T_9	PM 50 % + RFD 50 % 3.5 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	25.67	25.04	**25.55**
T_{10}	VC 50 % + RFD 50 % 7 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	25.08	24.92	**25.00**
T_{11}	Biofertilizer + RFD 50 % 2.5 kg Soil inoculant + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	24.39	24.24	**24.31**
T_{12}	Control (No organic manure or chemical fertilizers)	19.97	18.38	**19.15**
$C.D_{(p\leq0.05)}$		**1.30**	**1.37**	**0.94**

Treatment T_{10} (7 t VC + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) registered a vitamin C content of 25.08 and 24.92 mg 100 g^{-1} during *kharif*-2009 and *kharif*-2010, respectively and exhibited significant superiority over T_1, T_6 and T_{12} but was statistically at par with rest of the treatments. Pooled analysis revealed that treatment T_9 registered a vitamin C content of 25.55 mg 100 g^{-1}, which was significantly superior to treatment T_1, T_2, T_6, T_{11} and T_{12} but exhibited at par results with rest of other treatments. Treatment, T_{10} registered a vitamin C content of 25.00 mg 100 g^{-1}, which was significantly superior to T_1, T_6 and T_{12} but exhibited at par results with rest of the treatments (Table-8).

4.3.2 TSS (^{o}Brix)

Perusal of Table-9 revealed significant influence of various treatments on TSS (^{o}Brix) of fresh tomato fruits. Integration of organic sources with inorganic sources of plant nutrients exhibited an increase over sole application.

Among sole application of organic sources, treatment T_4 (PM 7 t ha^{-1}) recorded maximum TSS content of 5.20 and 5.14 (^{o}Brix) during *kharif* 2009 and *kharif* 2010, respectively and was found significantly superior to T_1, T_2, T_6 and T_{12} but exhibited at par results with T_3 and T_5 during both seasons. Pooled analysis revealed that treatment T_4 registered a maximum

Table-9 : Influence of organic and inorganic sources of plant nutrients on TSS (^{o}Brix) of Shalimar Tomato Hybrid-1

Treatments		Kharif		Pooled Mean
		2009	2010	
T_1	Recommended Fertilizer Dose (RFD) 190 N:150 P_2O_5:110 K_2O kg ha^{-1}	4.94	4.92	**4.93**
T_2	Farm Yard Manure (FYM) 38 t ha^{-1}	4.89	4.75	**4.82**
T_3	Sheep Manure (SM) 32 t ha^{-1}	5.15	5.06	**5.10**
T_4	Poultry Manure (PM) 7 t ha^{-1}	5.20	5.14	**5.17**
T_5	Vermicompost (VC) 14 t ha^{-1}	5.17	5.10	**5.13**
T_6	Biofertilizers (*Azospirillium* + *Phosphobacter*) 2.5 kg ha^{-1}	4.56	4.48	**4.52**
T_7	FYM 50 % + RFD 50 % 19 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	5.17	5.09	**5.13**
T_8	SM 50% + RFD 50 % 16 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	5.21	5.13	**5.17**
T_9	PM 50 % + RFD 50 % 3.5 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	5.27	5.19	**5.23**
T_{10}	VC 50 % + RFD 50 % 7 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	5.22	5.15	**5.18**
T_{11}	Biofertilizer + RFD 50 % 2.5 kg Soil inoculant + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	5.06	5.09	**5.07**
T_{12}	Control (No organic manure or chemical fertilizers)	4.14	4.12	**4.13**
$C.D_{(p\leq0.05)}$		**0.23**	**0.27**	**0.17**

TSS content of 5.17 (^{o}Brix) and was found significantly superior to T_1, T_2, T_6 and T_{12} but exhibited at par results with T_3 and T_5 (Table-9).

Combined application of organic sources of plant nutrients with inorganic one's in equal proportion (50:50) exhibited an increase in TSS content of fruits. Treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) registered maximum TSS content of 5.27 and 5.19 (^{o}Brix) during *kharif* 2009 and *kharif* 2010, respectively, and was found significantly superior to treatment T_1, T_2, T_6 and T_{12} but exhibited at par results with rest of the treatments during both seasons. Treatment T_{10} (7 t VC + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) registered a TSS content of 5.22 and 5.15 (^{o}Brix) during *kharif*-2009 and *kharif*-2010, respectively and was found significantly superior to T_1, T_2, T_6 and T_{12} but exhibited at par results with rest of the treatments. Pooled analysis revealed that treatment T_9 recorded a maximum TSS content of 5.23 (^{o}Brix) which was significantly superior to treatment T_1, T_2, T_6, T_{11} and T_{12} but exhibited at par results with rest of the treatments. Treatment T_{10} recorded a TSS content of 5.18 (^{o}Brix) which was significantly superior to treatment T_1, T_2, T_6 and T_{12} but exhibited at par results with rest of the treatments (Table-9).

4.3.3 Lycopene content (mg 100 g^{-1})

Perusal of Table-10 revealed significant effect of various treatments

Table-10: Influence of organic and inorganic sources of plant nutrients on lycopene content ($mg/100^{-1}g$) of Shalimar Tomato Hybrid-1

Treatments		Kharif		Pooled Mean
		2009	**2010**	
T_1	Recommended Fertilizer Dose (RFD) 190 N:150 P_2O_5:110 K_2O kg ha^{-1}	9.59	9.48	**9.53**
T_2	Farm Yard Manure (FYM) 38 t ha^{-1}	9.97	9.67	**9.82**
T_3	Sheep Manure (SM) 32 t ha^{-1}	10.00	9.68	**9.84**
T_4	Poultry Manure (PM) 7 t ha^{-1}	10.26	9.92	**10.09**
T_5	Vermicompost (VC) 14 t ha^{-1}	10.16	9.90	**10.03**
T_6	Biofertilizers (*Azospirillium* + *Phosphobacter*) 2.5 kg ha^{-1}	9.83	9.65	**9.74**
T_7	FYM 50 % + RFD 50 % 19 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	10.41	10.32	**10.36**
T_8	SM 50% + RFD 50 % 16 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	10.42	10.37	**10.39**
T_9	PM 50 % + RFD 50 % 3.5 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	11.45	11.28	**11.36**
T_{10}	VC 50 % + RFD 50 % 7 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	11.12	11.00	**11.06**
T_{11}	Biofertilizer + RFD 50 % 2.5 kg Soil inoculant + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	10.40	10.26	**10.32**
T_{12}	Control (No organic manure or chemical fertilizers)	6.67	6.58	**6.62**
$C.D_{(p\leq0.05)}$		**0.25**	**0.26**	**0.24**

on lycopene content (mg 100 g^{-1}). Integration of organic sources with inorganic sources of plant nutrients proved superior over sole applications.

Among sole application of organic sources, treatment T_4 (PM 7 t ha^{-1}) recorded a lycopene content of 10.26 and 9.92 mg 100 g^{-1} during *kharif* 2009 and *kharif* 2010, respectively and was found significantly superior to treatment T_1, T_2, T_6 and T_{12}. However, during *kharif* 2009 treatment T_4 also exhibited significant superiority over T_3 but was statistically at par with T_2 during *kharif*-2010 and T_5 during both the seasons. Pooled analysis revealed that treatment T_4 recorded a lycopene content of 10.09 (mg 100 g^{-1}) which was significantly superior to T_1, T_2, T_3, T_6 and T_{12} (control) but exhibited at par results to T_5 (VC 14 t ha^{-1}) (Table-10).

Conjugation of organic source with inorganic sources of plant nutrients in equal proportion 50:50 exhibited an improvement in lycopene content. Treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) registered a lycopene content of 11.45 and 11.28 mg 100 g^{-1} during *kharif* 2009 and *kharif* 2010, respectively and was found significantly superior to all treatments. Treatment T_{10} (7 t VC + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) recorded a lycopene content of 11.12 and 11.00 mg 100 g^{-1}) during *kharif*

2009 and *kharif* 2010, respectively and was found significantly superior to all treatments except T_9 (Table-10).

Pooled analysis revealed the significance of T_9 over rest of treatments recording a lycopene content of 11.36 mg 100 g^{-1}. Treatment T_{10} recorded a lycopene content of 11.06 mg 100 g^{-1} which was significantly superior to all treatments except T_9 (Table-10).

4.3.4 Protein content (%)

Perusal of the Table-11 revealed the significance of various treatments on protein content of tomato fruits. Integration of organic and inorganic sources of plant nutrients proved superior to sole applications.

Among sole application of organic sources, treatment T_4 (PM 7 t h^{-1}) recorded maximum protein content of 1.56 and 1.51 per cent during *kharif* 2009 and *kharif* 2010, respectively which was found significantly superior to T_2, T_3, T_6 and T_{12} (control) but exhibited at par results with T_5 (VC 14 t ha^{-1}) recording a protein content of 1.49 and 1.46 per cent during *kharif* 2009 and *kharif* 2010, respectively. However, T_4 treatment exhibited significantly lower values than T_1 (100 % RFD) recording a protein content of 1.63 and 1.61 per cent during *kharif* 2009 and *kharif* 2010, respectively. Pooled analysis revealed that treatment T_4 recorded a protein content of 1.53 per cent which was significantly superior to T_2, T_3, T_6 and T_{12} but

Table-11: Influence of organic and inorganic sources of plant nutrients on protein content (%) of Shalimar Tomato Hybrid-1

Treatments		Kharif 2009	Kharif 2010	Pooled Mean
T_1	Recommended Fertilizer Dose (RFD) 190 N:150 P_2O_5:110 K_2O kg ha^{-1}	1.63	1.61	**1.62**
T_2	Farm Yard Manure (FYM) 38 t ha^{-1}	1.45	1.43	**1.44**
T_3	Sheep Manure (SM) 32 t ha^{-1}	1.46	1.43	**1.44**
T_4	Poultry Manure (PM) 7 t ha^{-1}	1.56	1.51	**1.53**
T_5	Vermicompost (VC) 14 t ha^{-1}	1.49	1.46	**1.47**
T_6	Biofertilizers (*Azospirillium* + *Phosphobacter*) 2.5 kg ha^{-1}	1.44	1.42	**1.43**
T_7	FYM 50 % + RFD 50 % 19 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	1.57	1.51	**1.54**
T_8	SM 50% + RFD 50 % 16 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	1.68	1.62	**1.65**
T_9	PM 50 % + RFD 50 % 3.5 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	1.73	1.68	**1.69**
T_{10}	VC 50 % + RFD 50 % 7 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	1.70	1.67	**1.68**
T_{11}	Biofertilizer + RFD 50 % 2.5 kg Soil inoculant + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	1.56	1.56	**1.56**
T_{12}	Control (No organic manure or chemical fertilizers)	1.18	1.19	**1.18**
$C.D_{(p\leq 0.05)}$		**0.09**	**0.07**	**0.07**

exhibited at par results with T_5 recording a protein content of 1.47 per cent. However, T_4 recorded significantly lower protein content than T_1 recording a protein content of 1.62 per cent (Table-11).

Integration of organic sources with inorganic sources of plant nutrients in equal proportion (50:50) exhibited an increase in protein content. Treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) registered a protein content of 1.73 and 1.66 per cent during *kharif* 2009 and *kharif* 2010, respectively. Which was significantly superior to all treatments but exhibited at par results with T_8 and T_{10}. Treatment T_{10} (7 t VC + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) recorded a protein content of 1.70 and 1.66 per cent during *kharif* 2009 and *kharif* 2010, respectively and was found significantly superior to all treatments but exhibited at par results with T_1, T_8 and T_9 (Table-11).

Pooled analysis also revealed the significance of T_9 recording a protein content of 1.69 per cent which was significantly superior to all treatments but exhibited at par results with T_1, T_8 and T_{10}. treatment T_{10} registered a protein content of 1.68 per cent which was significantly superior over rest of the treatments except T_1, T_8 and T_9, where it exhibited at par results (Table-11).

4.3.5 Acidity (%)

Perusal of Table-12 indicate significant influence of various treatments on acidity of tomato fruit. Integration of organic sources with inorganic sources of plant nutrients exhibited an increase over sole applications.

Among sole application of organic sources, treatment T_4 (PM 7 t ha^{-1}) registered maximum acidity of 0.54 and 0.52 per cent during *kharif* 2009 and *kharif* 2010, respectively and was found significantly superior to T_1, T_6 and T_{12}, but exhibited at par results with T_2, T_3 and T_5. Pooled analysis also revealed that treatment T_4 registered a maximum acidity of 0.53 per cent and was significantly superior to T_1, T_6 and T_{12} but exhibited at par results with T_2, T_3 and T_5 (Table-12).

Combined application of organic sources of plant nutrients with inorganic ones in equal proportion (50:50) exhibited an increase in acidity per cent of fruits. Treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) recorded 0.58 and 0.57 per cent acidity during *kharif* 2009 and *kharif* 2010, respectively. Which exhibited significant superiority over other treatments but was statistically at par with T_8 and T_{10} (Table-12). Treatment T_{10} (7 t VC + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) registered 0.57 per cent acidity during *kharif* 2009 and was found significantly superior to all treatment

Table-12: Influence of organic and inorganic sources of plant nutrients on fruit acidity (%) of Shalimar Tomato Hybrid-1

Treatments		Kharif		Pooled Mean
		2009	2010	
T_1	Recommended Fertilizer Dose (RFD) 190 N:150 P_2O_5:110 K_2O kg ha^{-1}	0.50	0.47	**0.46**
T_2	Farm Yard Manure (FYM) 38 t ha^{-1}	0.51	0.49	**0.50**
T_3	Sheep Manure (SM) 32 t ha^{-1}	0.51	0.51	**0.51**
T_4	Poultry Manure (PM) 7 t ha^{-1}	0.54	0.52	**0.53**
T_5	Vermicompost (VC) 14 t ha^{-1}	0.53	0.51	**0.52**
T_6	Biofertilizers (*Azospirillium* + *Phosphobacter*) 2.5 kg ha^{-1}	0.48	0.47	**0.47**
T_7	FYM 50 % + RFD 50 % 19 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	0.52	0.51	**0.51**
T_8	SM 50% + RFD 50 % 16 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	0.56	0.54	**0.55**
T_9	PM 50 % + RFD 50 % 3.5 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	0.58	0.57	**0.57**
T_{10}	VC 50 % + RFD 50 % 7 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	0.57	0.54	**0.55**
T_{11}	Biofertilizer + RFD 50 % 2.5 kg Soil inoculant + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	0.51	0.50	**0.50**
T_{12}	Control (No organic manure or chemical fertilizers)	0.38	0.36	**0.37**
$C.D_{(p\leq0.05)}$		**0.03**	**0.04**	**0.03**

except T_8 and T_9, where the results were statistically at par. During *kharif* 2010, T_{10} registered 0.5 per cent acidity which was significantly superior to T_1, T_2, T_6 and T_{12} but exhibited at par results with rest of the treatments.

Pooled analysis indicate that T_9 recorded an acidity of 0.57 per cent which was significantly superior to other treatments but exhibited at par results with T_8 and T_{10}. Treatment $T_{10,}$ registered an acidity of 0.55 per cent which was significantly superior to all treatments but exhibited at par results with T_8 and T_9 (Table-12)

4.4 Influence of organic and inorganic sources of plant nutrients on chemical characteristics of soil

4.4.1 Soil organic carbon

Perusal of Table-13 revealed significance of various treatments on organic carbon content. Integration of organic and inorganic sources of plant nutrients prove superior in enhancing organic carbon content as compared to sole applications.

Among sole application of organic sources, treatment T_4 (PM 7 t ha^{-1}) recorded an organic carbon content of 1.27 and 1.29 per cent after the harvest of crop during *kharif* 2009 and *kharif* 2010, respectively, which was significantly superior to T_1, T_2, T_6 and T_{12} (control) including initial (1.13 %) during both seasons. But exhibited at par results with T_5 (VC 14 t ha^{-1})

Table-13: Influence of organic and inorganic sources of plant nutrients on organic carbon (%)

Treatments		Kharif	
		2009	2010
T_1	Recommended Fertilizer Dose (RFD) 190 N:150 P_2O_5:110 K_2O kg ha^{-1}	1.15	1.16
T_2	Farm Yard Manure (FYM) 38 t ha^{-1}	1.22	1.24
T_3	Sheep Manure (SM) 32 t ha^{-1}	1.24	1.26
T_4	Poultry Manure (PM) 7 t ha^{-1}	1.27	1.29
T_5	Vermicompost (VC) 14 t ha^{-1}	1.26	1.27
T_6	Biofertilizers (*Azospirillium* + *Phosphobacter*) 2.5 kg ha^{-1}	1.15	1.16
T_7	FYM 50 % + RFD 50 % 19 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	1.21	1.22
T_8	SM 50% + RFD 50 % 16 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	1.23	1.25
T_9	PM 50 % + RFD 50 % 3.5 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	1.28	1.30
T_{10}	VC 50 % + RFD 50 % 7 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	1.26	1.28
T_{11}	Biofertilizer + RFD 50 % 2.5 kg Soil inoculant + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	1.16	1.18
T_{12}	Control (No organic manure or chemical fertilizers)	1.00	1.04
$C.D_{(p\leq0.05)}$		**0.02**	**0.04**
Initial		**1.13**	

recording an organic carbon content of 1.26 and 1.27 per cent during both the seasons, respectively. However during *kharif* 2009 T_4 exhibited significant superiority over T_3 but during *kharif* 2010 the results were statistically at par (Table-13).

Integration of organic sources of plant nutrients with inorganic sources in equal proportions (50:50) increased the organic carbon content as compared to sole applications. Treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) registered an organic carbon content of maximum 1.28 and 1.30 per cent during *kharif* 2009 and *kharif* 2010, respectively and was significantly superior, to T_1, T_2, T_3 (during *kharif* 2009), T_6, T_7, T_8 and T_{12} including initial (1.13 %), but exhibited at par results with rest of the treatments (Table-13). Treatment T_{10} (7 t VC + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) recorded an organic carbon content of 1.26 and 1.28 per cent during *kharif* 2009 and *kharif* 2010, respectively and was found significantly superior to T_1, T_2 (during *kharif* 2009), T_6, T_7, T_8 (during *kharif* 2009) and T_{12} including initial but was statistically at par with rest of the treatments.

4.4.2 Soil pH

Perusal of Table-14 revealed that significance of various treatments on soil pH. Integration of organic and inorganic sources of plant nutrients proved superior in decreasing the soil pH over sole applications.

Table-14: Influence of organic and inorganic sources of plant nutrients on soil pH

Treatments		Kharif	
		2009	2010
T_1	Recommended Fertilizer Dose (RFD) 190 N:150 P_2O_5:110 K_2O kg ha^{-1}	7.08	7.07
T_2	Farm Yard Manure (FYM) 38 t ha^{-1}	7.08	7.04
T_3	Sheep Manure (SM) 32 t ha^{-1}	7.06	7.00
T_4	Poultry Manure (PM) 7 t ha^{-1}	7.02	6.97
T_5	Vermicompost (VC) 14 t ha^{-1}	7.05	7.00
T_6	Biofertilizers (*Azospirillium* + *Phosphobacter*) 2.5 kg ha^{-1}	7.13	7.07
T_7	FYM 50 % + RFD 50 % 19 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	7.03	7.01
T_8	SM 50% + RFD 50 % 16 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	7.02	7.00
T_9	PM 50 % + RFD 50 % 3.5 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	6.97	6.85
T_{10}	VC 50 % + RFD 50 % 7 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	7.00	6.98
T_{11}	Biofertilizer + RFD 50 % 2.5 kg Soil inoculant + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	7.02	7.00
T_{12}	Control (No organic manure or chemical fertilizers)	7.15	7.18
$C.D_{(p \leq 0.05)}$		**0.04**	**0.03**
Initial		**7.21**	

Among sole application of organic sources, treatment T_4 (PM 7 t ha^{-1}) registered a pH of 7.02 and 6.97 after the harvest of crop during *kharif* 2009 and *kharif* 2010, respectively and was significantly lower than T_1, T_2, T_6, T_{12} and initial (7.21) but exhibited at par results with T_3 and T_5 during both seasons (Table-14).

Integration of organic sources with inorganic sources of plant nutrients in equal proportion (50:50) exhibited a decline in soil pH. Treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) recorded a soil pH of 6.97 and 6.85 after the harvest of crop during *kharif* 2009 and *kharif* 2010, respectively which was significantly lower than rest of treatments including initial but exhibited at par results with treatment T_{10} during *kharif* 2009 (Table-14). Treatment T_{10} (7 t VC + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) recorded a soil pH of 7.00 and 6.98 after the harvest of crop during *kharif* 2009 and *kharif* 2010, respectively and was found significant lower than T_1, T_2, T_3 (during *kharif* 2009), T_5 (during *kharif* 2009), T_6, T_{12}, including initial. But exhibited at par results to rest of other treatments.

4.4.3 Electrical conductivity

Perusal of Table-15 revealed significant variations for electrical conductivity. Integration of organic sources and inorganic sources of plant nutrients proved superior to sole applications.

Table-15: Influence of organic and inorganic sources of plant nutrients on electrical conductivity (dSm^{-1})

Treatments		Kharif	
		2009	2010
T_1	Recommended Fertilizer Dose (RFD) 190 N:150 P_2O_5:110 K_2O kg ha^{-1}	0.106	0.108
T_2	Farm Yard Manure (FYM) 38 t ha^{-1}	0.107	0.111
T_3	Sheep Manure (SM) 32 t ha^{-1}	0.112	0.113
T_4	Poultry Manure (PM) 7 t ha^{-1}	0.118	0.120
T_5	Vermicompost (VC) 14 t ha^{-1}	0.114	0.116
T_6	Biofertilizers (*Azospirillium* + *Phosphobacter*) 2.5 kg ha^{-1}	0.107	0.109
T_7	FYM 50 % + RFD 50 % 19 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	0.118	0.120
T_8	SM 50% + RFD 50 % 16 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	0.121	0.122
T_9	PM 50 % + RFD 50 % 3.5 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	0.126	0.129
T_{10}	VC 50 % + RFD 50 % 7 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	0.123	0.125
T_{11}	Biofertilizer + RFD 50 % 2.5 kg Soil inoculant + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	0.116	0.119
T_{12}	Control (No organic manure or chemical fertilizers)	0.092	0.093
$C.D_{(p\leq0.05)}$		**0.0019**	**0.0013**
Initial		**0.090**	

Among sole application of organic sources, treatment T_4 (PM 7 t ha^{-1}) recorded an electrical conductivity of 0.118 and 0.120 dSm^{-1} after the harvest of crop during *kharif* 2009 and *kharif* 2010 respectively and was found significantly superior to T_1, T_2, T_3, T_5, T_6 and T_{12} (control) including initial (0.090) during both seasons (Table-15).

Integration of organic source with inorganic source of plant nutrients in equal proportions 50:50 exhibited an increase in electrical conductivity as compared to sole applications. Treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) recorded an electrical conductivity of 0.126 and 0.129 dSm^{-1} after harvest of crop during *kharif* 2009 and *kharif* 2010, respectively and was found significantly superior to all treatments. Treatment T_{10} (7 t VC + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) registered an electrical conductivity of 0.123 and 0.125 dSm^{-1} after the harvest of crop during *kharif* 2009 and *kharif* 2010 respectively and was significantly superior to all treatments except treatment T_9 (Table-15).

4.4.4 Soil available nitrogen (kg ha^{-1})

Perusal of Table-16 indicated significant variation of available nitrogen in soil due to various treatments. Integration of organic and inorganic sources proved superior in enhancing the availability of nitrogen in soil as compared to sole applications.

Table-16: Influence of organic and inorganic sources of plant nutrients on soil available nitrogen (kg ha^{-1})

Treatments		Kharif	
		2009	**2010**
T_1	Recommended Fertilizer Dose (RFD) 190 N:150 P_2O_5:110 K_2O kg ha^{-1}	248.97	251.57
T_2	Farm Yard Manure (FYM) 38 t ha^{-1}	255.18	257.87
T_3	Sheep Manure (SM) 32 t ha^{-1}	261.17	265.99
T_4	Poultry Manure (PM) 7 t ha^{-1}	264.75	270.22
T_5	Vermicompost (VC) 14 t ha^{-1}	263.85	265.78
T_6	Biofertilizers (*Azospirillium* + *Phosphobacter*) 2.5 kg ha^{-1}	252.22	254.60
T_7	FYM 50 % + RFD 50 % 19 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	264.86	269.74
T_8	SM 50% + RFD 50 % 16 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	268.54	273.79
T_9	PM 50 % + RFD 50 % 3.5 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	280.91	284.30
T_{10}	VC 50 % + RFD 50 % 7 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	270.23	274.40
T_{11}	Biofertilizer + RFD 50 % 2.5 kg Soil inoculant + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	258.57	262.35
T_{12}	Control (No organic manure or chemical fertilizers)	150.78	152.37
$C.D_{(p\leq0.05)}$		**5.35**	**4.66**
Initial		**246.00**	

Among sole application of organic sources, treatment T_4 (PM 7 t ha^{-1}) registered an available nitrogen content of 264.75 and 270.22 kg ha^{-1} after the harvest of crop during *kharif* 2009 and *kharif* 2010, respectively and was found significantly superior to T_1, T_2, T_6 and T_{12} (control) including initial (246.00 kg ha^{-1}), but results were statistically at par with T_3 during *kharif* 2009 only and with T_5 during both seasons (Table-16).

Integration of organic sources with inorganic sources of plant nutrients in equal proportions (50:50) depicted higher values for available nitrogen build up in soil over sole applications. Treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) recorded an available nitrogen content of 280.91 and 284.30 kg ha^{-1} during *kharif* 2009 and 2010, respectively and was significantly superior to all treatments including the initial during both seasons.

Treatment T_{10} recorded an available nitrogen content of 270.23 and 274.40 kg ha^{-1} during *kharif* 2009 and *kharif* 2010, respectively and was significantly superior to all treatments and initial status except T_9. Results recorded with T_{10} were statistically at par to T_4 during *kharif* 2010 only and T_8, during both seasons (Table-16).

4.4.5 Soil available phosphorus (kg ha^{-1})

Perusal of Table-17 revealed significant variations for available phosphorus content in the soil. Among various treatments, integration of organic sources of plant nutrients with inorganic sources proved superior in available phosphorus build up in the soil as compared to sole applications.

Among sole application of organic sources, treatment T_4 (PM 7 t ha^{-1}) recorded an available phosphorus content of 36.33 and 38.18 kg ha^{-1} after the harvest of crop during *kharif* 2009 and *kharif* 2010, respectively. Which was found significantly superior to T_1, T_6, T_{12} and initial (20.18 kg ha^{-1}) but exhibited at par results with T_2, T_3, T_5 during both seasons (Table-17).

Integration of organic sources of plant nutrients with inorganic sources in equal proportions (50:50) depicted an increase in available phosphorus content than sole applications. Treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) recorded maximum phosphorus content of 46.01 and 47.60 kg ha^{-1} after the harvest of crop during *kharif* 2009 and *kharif* 2010, respectively and was found significantly superior to all other treatments. Treatment T_{10} (7 t VC + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) registered a phosphorus content of 39.67 and 41.60 kg ha^{-1} after the harvest of crop during *kharif* 2009 and *kharif* 2010, respectively and was found

Table-17: Influence of organic and inorganic sources of plant nutrients on soil available phosphorus (kg ha^{-1})

Treatments		Kharif	
		2009	2010
T_1	Recommended Fertilizer Dose (RFD) 190 N:150 P_2O_5:110 K_2O kg ha^{-1}	28.03	29.32
T_2	Farm Yard Manure (FYM) 38 t ha^{-1}	33.87	34.76
T_3	Sheep Manure (SM) 32 t ha^{-1}	34.19	35.65
T_4	Poultry Manure (PM) 7 t ha^{-1}	36.33	38.18
T_5	Vermicompost (VC) 14 t ha^{-1}	34.91	36.53
T_6	Biofertilizers (*Azospirillium* + *Phosphobacter*) 2.5 kg ha^{-1}	23.92	25.95
T_7	FYM 50 % + RFD 50 % 19 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	37.62	40.35
T_8	SM 50% + RFD 50 % 16 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	35.91	37.68
T_9	PM 50 % + RFD 50 % 3.5 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	46.01	47.60
T_{10}	VC 50 % + RFD 50 % 7 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	39.67	41.60
T_{11}	Biofertilizer + RFD 50 % 2.5 kg Soil inoculant + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	30.37	31.67
T_{12}	Control (No organic manure or chemical fertilizers)	13.87	15.17
$C.D_{(p\leq0.05)}$		**4.64**	**4.25**
Initial		**20.18**	

significantly superior to all treatments and initial status except T_9 but exhibited at par results with T_7 and T_8 (Table-17).

4.4.6 Soil available potassium (kg ha^{-1})

Perusal of Table-18 revealed significant influence of various treatments on potassium build up in soil. Among various treatments, combination of organic and inorganic sources of plant nutrients proved superior to sole applications.

Among sole application of organics, treatment T_4 (PM 7 t ha^{-1}) registered an available potassium content of 207.68 and 210.16 kg ha^{-1} after the harvest of crop during *kharif* 2009 and *kharif* 2010, respectively and was found significantly superior to T_1, T_2, T_3, $T_{6,}$ T_{12} and initial status (191.20 kg ha^{-1}) but exhibited at par results with T_5 (VC 14 t ha^{-1}) during both seasons (Table-18).

Integration of organic sources of plant nutrients with inorganic sources of plant nutrients in equal proportions (50:50) exhibited an increase in available potassium content over sole applications. Treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) recorded an available potassium content of 219.81 and 222.27 kg ha^{-1} after the harvest of crop during *kharif* 2009 and *kharif* 2010, respectively and was found significant superior to all treatment and initial status but exhibited at par results with T_{10}. Treatment

Table-18: Influence of organic and inorganic sources of plant nutrients on soil available potassium (kg/ha)

Treatments		Kharif	
		2009	2010
T_1	Recommended Fertilizer Dose (RFD) 190 N:150 P_2O_5:110 K_2O kg ha^{-1}	194.07	195.28
T_2	Farm Yard Manure (FYM) 38 t ha^{-1}	198.18	201.23
T_3	Sheep Manure (SM) 32 t ha^{-1}	201.15	204.10
T_4	Poultry Manure (PM) 7 t ha^{-1}	207.68	210.16
T_5	Vermicompost (VC) 14 t ha^{-1}	205.48	208.95
T_6	Biofertilizers (*Azospirillium* + *Phosphobacter*) 2.5 kg ha^{-1}	195.30	196.51
T_7	FYM 50 % + RFD 50 % 19 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	207.30	210.02
T_8	SM 50% + RFD 50 % 16 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	212.93	214.93
T_9	PM 50 % + RFD 50 % 3.5 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	219.81	222.27
T_{10}	VC 50 % + RFD 50 % 7 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	216.92	218.26
T_{11}	Biofertilizer + RFD 50 % 2.5 kg Soil inoculant + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	201.13	202.22
T_{12}	Control (No organic manure or chemical fertilizers)	144.5	146.22
C.D$_{(p\leq0.05)}$		**4.64**	**4.05**
Initial		**191.20**	

T_{10} (7 t VC + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) recorded a potassium content of 216.92 and 218.26 kg ha^{-1} after the harvest of the crop during *kharif* 2009 and *kharif* 2010 which was significantly superior to all treatment except T_8 and T_9 (Table-18).

4.5 Economics of production in tomato

4.5.1 Cost structure in tomato crop

Since all other operations except the use of organic sources, chemical fertilizers and their spreading were common, under all treatments. The additional cost incurred on this account was added to the expenditure on all treatments except control (Table-19).

The cultivation of tomato turned labour intensive and created an employment of 278 labour day ha^{-1} from ploughing of land upto the harvesting of crop.

Maximum cost of cultivation (Rs. 101427.20) was estimated in T_5 (vermicompost 14 ha^{-1}) and the lowest in T_6 (biofertilizers 2.5 kg ha^{-1}) and T_{12} which respectively accounted for Rs. 59307.20 ha^{-1} and Rs. 58767.20 ha^{-1}.

4.5.2 Income distribution and benefit cost ratio

Perusal of Table-22 revealed that the position of input and output in terms of economics of production. The treatment-wise cost of cultivation and their returns revealed that maximum returns of Rs. 314622.80 were registered with T_4 (poultry manure 7 t ha^{-1}) followed by T_3 (sheep manure 32 ha^{-1}) and T_5 (vermicompost 14 t ha^{-1}). With returns per rupee invested of 5.28, 4.30 and 3.77, respectively.

Integration of organic sources of plant nutrients with inorganic sources did not exhibit an increase in net returns as compared to sole applications. The maximum returns of Rs. 251678.80 were recorded with T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) followed by T_{10} (7 t VC + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) and T_8 (16 t SM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) with return per rupee invested of 4.61, 3.73 and 3.93, respectively. The lowest return of Rs. 90788.80 were recorded with T_{12} (control) followed by T_{11} (2.5 kg Soil inoculant + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) and T_7 (19 t FYM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) with returns of Re^{-1} invested of 2.54, 3.71 and 3.53, respectively.

Table-19: Treatment wise added cost in the cultivation of Shalimar Tomato Hybrid-1

Treatments		Cost involved on		Number of labours for spreading @ 110/labour	Amount involved (Rs.)	Total added cost (Rs./ha)
		Fertilizer	Manure			
T_1	Recommended Fertilizer Dose (RFD) 190 N:150 P_2O_5:110 K_2O kg ha^{-1}	6280.00	-	10	1100.00	9880.00
T_2	Farm Yard Manure (FYM) 38 t ha^{-1}	-	19000.00	10	1100.00	20100.00
T_3	Sheep Manure (SM) 32 t ha^{-1}	-	25600.00	10	1100.00	26700.00
T_4	Poultry Manure (PM) 7 t ha^{-1}	-	14000.00	8	880.00	14880.00
T_5	Vermicompost (VC) 14 t ha^{-1}	-	42000.00	8	880.00	42880.00
T_6	Biofertilizers (*Azospirillium* + *Phosphobacter*) 2.5 kg ha^{-1}	-	100.00	6	660.00	760.00
T_7	FYM 50 % + RFD 50 % 19 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	3140.00	9500.00	10	1100.00	13740.00
T_8	SM 50% + RFD 50 % 16 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	3140.00	12800.00	10	1100.00	17040.00
T_9	PM 50 % + RFD 50 % 3.5 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	3140.00	7000.00	8	880.00	11020.00
T_{10}	VC 50 % + RFD 50 % 7 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	3140.00	21000.00	8	880.00	25020.00
T_{11}	Biofertilizer + RFD 50 % 2.5 kg Soil inoculant + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	3140.00	100.00	8	880.00	4120.00
T_{12}	Control (No organic manure or chemical fertilizers)	-	-	2	220.00	220.00

Table-20 : Cost of cultivation of (Shalimar Tomato Hybrid-1)

Cost involved on variable and fixed factors		Rs./ha
A)	Nursery raising	150.00
	Preparation/sowing, management (10 labourers @ Rs. 110 per labourer)	1100.00
Total (A)		**1250.00**
B)	Prepatory tillage (three ploughings @ Rs. 3000 ha^{-1}	9000.00
	Clod breaking/leveling (20 labourers @ Rs. 110 per labour)	2200.00
	Preparation of beds/channels (35 labourers @ Rs. 110 per labour)	3850.00
	Planting of seedlings (35 labourers @ Rs. 110.00 per labourer)	3850.00
Total (B)		**18900.00**
C)	Irrigation (five irrigations – 15 labourers @ Rs. 110 per labourer)	1650.00
D)	Cultural operations (three hand weedings/hoeings (40 labourers @ Rs. 110 per labourer)	4400.00
E)	After care operations (10 labourers @ Rs. 110 per labourer)	1100.00
F)	Harvesting (fruit picking – 8 pickings, 5 labourers for each picking @ Rs. 110.00 per labourer	4400.00
	Removal of crop residues and stakings (10 labourers @ Rs. 110 per labourer)	1100.00
Total (C+D+E+F)		**12650.00**
Total (A+B+C+D+E+F)		**32800.00**
	Incidental charges @ 5% of the working capital	1640.00
	Total labour component involved in total cost of cultivation	34440.00
G)	Cost of seed @ Rs. 10,000 kg^{-1} for 400 g ha^{-1}	4000.00
Total (G)		**4000.00**
Variable cost (labour + cost of seed :: 3440 + 4000)		38440.00
Land rent @ Rs. 900 $kanal^{-1}$		18000.00
Land tax		80.00
Depreciation of implements		800.00
Total		**18880.00**
Interest @ 6.5% on fixed factor		1227.20
Total fixed cost (18880+1227.20)		20107.20

Table-21 : Treatmentwise comparative economics of cost of cultivation of Shalimar Tomato Hybrid-1

Treatments		Fixed cost (Rs. ha^{-1})	Variable cost (Rs. ha^{-1})	Added cost (Rs. ha^{-1})	Total variable cost (Rs. ha^{-1})	Total cost of cultivation (Rs.)
T_1	Recommended Fertilizer Dose (RFD) 190 N:150 P_2O_5:110 K_2O kg ha^{-1}	20107.20	38440.00	9880.00	48320.00	68427.20
T_2	Farm Yard Manure (FYM) 38 t ha^{-1}	20107.20	38440.00	20100.00	58540.00	78647.20
T_3	Sheep Manure (SM) 32 t ha^{-1}	20107.20	38440.00	26700.00	65140.00	85247.20
T_4	Poultry Manure (PM) 7 t ha^{-1}	20107.20	38440.00	14880.00	53320.00	73427.20
T_5	Vermicompost (VC) 14 t ha^{-1}	20107.20	38440.00	42880.00	81320.00	101427.20
T_6	Biofertilizers (*Azospirillium* + *Phosphobacter*) 2.5 kg ha^{-1}	20107.20	38440.00	760.00	39200.00	59307.20
T_7	FYM 50 % + RFD 50 % 19 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	20107.20	38440.00	13740.00	52180.00	72287.20
T_8	SM 50% + RFD 50 % 16 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	20107.20	38440.00	17040.00	55480.00	75587.20
T_9	PM 50 % + RFD 50 % 3.5 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	20107.20	38440.00	11020.00	49460.00	69567.20
T_{10}	VC 50 % + RFD 50 % 7 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	20107.20	38440.00	25020.00	63460.00	83567.20
T_{11}	Biofertilizer + RFD 50 % 2.5 kg Soil inoculant + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	20107.20	38440.00	4120.00	42560.00	62667.20
T_{12}	Control (No organic manure or chemical fertilizers)	20107.20	38440.00	220.00	38660.00	58767.20

Table-22: Economics of production under different treatments in the cultivation of Shalimar Tomato Hybrid-1

Treatments		Total cost of cultivation (Rs. ha^{-1})	Pooled yield (q ha^{-1})	Gross return (Rs. ha^{-1})	Added return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	Returns Rs.$^{-1}$
T_1	Recommended Fertilizer Dose (RFD) 190 N:150 P_2O_5:110 K_2O kg ha^{-1}	68427.20	524.80	314880.00	165324.00	246452.80	4.60
T_2	Farm Yard Manure (FYM) 38 t ha^{-1}	78647.20	327.86	327860.00	178304.00	249212.80	4.16
T_3	Sheep Manure (SM) 32 t ha^{-1}	85247.20	367.29	367290.00	217734.00	282042.80	4.30
T_4	Poultry Manure (PM) 7 t ha^{-1}	73427.20	388.05	388050.00	238494.00	314622.80	5.28
T_5	Vermicompost (VC) 14 t ha^{-1}	101427.20	383.05	383050.00	233494.00	281622.80	3.77
T_6	Biofertilizers (*Azospirillium* + *Phosphobacter*) 2.5 kg ha^{-1}	59307.20	299.10	299100.00	149544.00	239792.80	5.04
T_7	FYM 50 % + RFD 50 % 19 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	72287.20	426.05	255630.00	106074.00	183342.80	3.53
T_8	SM 50% + RFD 50 % 16 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	75587.20	495.30	297180.00	147624.00	221592.80	3.93
T_9	PM 50 % + RFD 50 % 3.5 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	69567.20	535.41	321246.00	171690.00	251678.80	4.61
T_{10}	VC 50 % + RFD 50 % 7 t + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	83567.20	520.13	312078.00	162522.00	228510.80	3.73
T_{11}	Biofertilizer + RFD 50 % 2.5 kg Soil inoculant + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}	62667.20	388.48	233088.00	83532.00	190420.80	3.71
T_{12}	Control (No organic manure or chemical fertilizers)	58767.20	249.26	149556.00	-	907880.80	2.54

Organic Tomato = Rs. 1000 q^{-1}; Inorganic Tomato = Rs. 600 q^{-}

CHAPTER – 5

DISCUSSION

Tomato (*Lycopersicon esculentum* Mill.) is one of the popular vegetable grown in India and also in Jammu and Kashmir (J&K). The climate of J&K is very much suited to the cultivation of tomato. Its production can be increased by selecting high yielding varieties and hybrids, improved cultural practices and proper plant nutrient and protection measures. Among the management practices, application of fertilizers to meet the nutrient requirement of the crop is undoubtedly of prime importance. Tomato being a heavy feeder and long duration crop removes large quantities of major elements like N, P and K and therefore balanced nutrition is of paramount significance in growth and productivity of tomato. Balanced fertilization based on the concept of integrated nutrient management in a cropping system advocates the complimentary use of chemical fertilizers and organic manures, is most important in maintaining soil productivity under sustainable agriculture production system which utilizes all the available sources of plant nutrients in a judicious and efficient manner.

Since no such information is available on nutritional requirement of hybrid tomato under Kashmir condition, the present investigation was therefore undertaken to find out a balanced schedule of organic manure and inorganic sources of plant nutrients for obtaining maximum yield and better quality in recently developed Shalimar Tomato Hybrid-1 under temperate conditions of Kashmir and the results of present investigation are discussed in this chapter under various sub heading :

5.1 Growth attributes

The pooled data presented in Table-2 and 3, revealed that maximum value for plant height (130.06 cm) and number of branches plant^{-1} (11.46), was observed in treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) followed by T_{10}. Among sole application of organics, treatment T_4 (PM = 7 t ha^{-1}) recorded higher values for plant height (96.50 cm) and number of branches plant^{-1} (8.49) followed by T_5.

Integration of individual organic sources with inorganic sources of plant nutrients in equal proportions registered higher values for growth attributes.

Integration of organic and inorganic sources of plant nutrients exhibited an increase in growth related attributes of tomato. This increase is due to balanced C:N ratio, better organic matter build up, efficient microbial activity, better root proliferation abundant supply and availability of nutrients from soil, more translocation of nutrients to aerial parts for protoplasmic protein and synthesis of other compounds (Singh *et al*., 1970). Superiority of poultry manure over farmyard manure, sheep manure, vermicompost and biofertilizers in improvement of growth related characters of tomato can be attributed to its nutritional richness, quick mineralization, more availability of nitrogen and other plant nutrients. Besides this poultry manure contains uric acid having 60 per cent nitrogen which gets rapidly converted to ammonical form and becomes readily available to plants. These results obtained in the present study are in line with those of Singh and Srivastava (1973) in potato, Jose *et al*. (1988) in brinjal, Harikrishna *et al*. (2002) in tomato, Magray (2002) in capsicum, Prabu *et al*. (2003) in okra, Swain *et al*. (2003) in okra and Malik *et al*. (2009) in capsicum, Dass *et al*. (2002) in tomato.

5.2 Yield attributes

The pooled data presented in Table-4,5,6 and 7 revealed that significantly higher values for number of fruits plant^{-1} (62.31), fruit diameter (5.25 cm), average fruit weight (59.75 g) and fruit yield ha^{-1} (535.41 q) was observed in treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) followed by T_{10}.

Among sole application of organic sources, T_4 (PM = 7 t ha^{-1}) recorded higher values (47.13, 4.59 cm, 53.86 g, 388.05 q) for number of fruits $plant^{-1}$, fruit diameter, average fruit weight, fruit yield ha^{-1}, respectively.

Integration of different organic sources and inorganic sources of plant nutrients exhibited an increase in yield and yield related attributes of tomato. This is possibly due to balanced C:N ratio, more decomposition, more mineralization, more availability of native and applied macro and micro-nutrients. All these might have accelerated the synthesis of carbohydrates and its better translocation from sink to source might have led to an improvement in yield and yield related attributes.

Poultry manure proved its superiority in enhancing yield and yield related attributes of tomato over rest of the organic sources (Farm yard manure, sheep manure, vermicompost and biofertilizers). Whether used as a sole or in conjugation with in-organic sources.

This superiority could be attributed to nutritional richness, production of growth promoting substances, balanced C:N ratio, and efficient microbial activity leading to sustainable nutrient availability and improvement in soil physical conditions. The higher values for yield and yield related attributes due to inorganic fertilizers could be attributed to quick release of nutrients in sufficient amount.

These results are in conformity with the findings of Naidu *et al.* (2000) in okra, Harikrishna *et al.* (2002) in tomato, Magray (2002) in capsicum, Rafi *et al.* (2002) in tomato, Prabu *et al.* (2003) in okra, Malik *et al.* (2009) in capsicum.

5.3 Quality attributes

The pooled data in Table-8 to 12 revealed maximum values for vitamic C content (25.35 mg 100^{-1} g), TSS (5.23 ^{o}Brix), lycopene content (11.36 mg 100^{-1} g), protein content (1.69%), acidity (0.57 %) were observed in treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) followed by T_{10}. Among sole application of organic sources of plant nutrients, poultry manure 7 t ha^{-1} recorded higher values of (25.04 mg 100^{-1} g, 5.17 ^{o}Brix, 10.09 mg 100^{-1} g, 1.51 %, 0.53 %) for vitamin C content, TSS, Lycopene content and acidity. Treatment T_{12} (control) recorded lower value for all the quality attributes.

Improvement in quality attributes of tomato due to integration of organic and inorganic sources of plant nutrients could be attributed to better and balanced nutrition and production of growth promoting substances by organics which might have led to better quality like vitamin C, lycopene and protein content. Improvement in quality of tomato can also be attributed to improvement in soil physical, chemical and biological properties which might have led to better root proliferation, improved nutrient uptake and better accumulation of photosynthates. While in chemical fertilizers reduction in quality attributes in comparison to integration could be attributed to the fact that these provide either single or sometimes two essential nutrients but not other nutrients. The superiority of poultry manure and vermincompost can be attributed to their nutritional richness, as well as to their stimulatory behavior.

Our findings are in conformity with the findings of other workers Jose *et al*. (1988) in brinjal, Singh *et al*. (2000) in brinjal, Megray *et al*. (2002) in capsicum, Rafi *et al*. (2002) in tomato, Juroszek *et al*. (2007) in tomato, Malik *et al*. (2009) in capsicum, Premsekhar *et al*. (2009) in tomato.

5.4 Soil chemical characteristics

The data regarding soil chemical characteristics viz., organic carbon, pH as influenced by various treatments after the harvest of crop is depicted in Table-13 to 15.

Higher organic carbon content, lower pH and maximum electrical conductivity was observed in treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) followed by T_{10}. Among sole application of organics, higher organic carbon content, lower pH and higher electrical conductivity was registered in treatment T_4 (PM = 7 t ha^{-1}) followed by T_5. Increase in organic carbon content of soil due to integrations can be attributed to narrow C:N ratio, leading more decomposition, more microbial population, enhanced biological conservation and higher build up of organic carbon. The decrease in soil pH could be attributed to acidying effect of organic acids like lactic acid, formic acid produced during decomposition of organic manures. Decrease in pH results an increase in electrical conductivity. Superiority of poultry manure in improving soil chemical characteristics over rest of the organic sources can be attributed to the fact that poultry manure is rich in essential nutrients and decomposes quickly, thereby helps in building up of more organic carbon content. Similar trend has also been reported by other research workers Shelke *et al.* (1999); Perumal *et al.* (2003); Gogoi *et al.* (2004); Swain *et al.* (2003).

5.5 Nutrient availability

The data regarding the availability of nitrogen, phosphorus and potassium as influenced by various treatments after the harvest of crop are presented in Table-16 to 18. Maximum availability of nitrogen (280.91, 284.30 kg ha^{-1}), phosphorus (46.01, 47.60 kg ha^{-1}) and potassium (219.80, 222.27 kg ha^{-1}) during *kharif* 2009 and 2010, respectively was observed in treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) followed by T_{10}. Sole application of organic sources of plant nutrients registered higher build up of nitrogen (264.75, 270.22 kg ha^{-1}), phosphorus (36.33, 38.18 kg ha^{-1}), potassium (207.68, 210.16 kg ha^{-1}) during *kharif* 2009 and 2010, respectively with treatment T_4 (PM = 7 t ha^{-1}) followed by T_5 the increased nutrient availability with organic and inorganic sources of plant nutrients could be attributed to residual effects of organic manure, balanced C:N ratio, more decomposition enhanced biomass addition which contains humans (a source of plant nutrients), production of organic acid which makes insoluble forms of nutrients into available forms.

Another reason for enhanced nutrient availability could be due to decomposition of certain complex components like calcium carbonates into soluble forms, production of carbon dioxide and organic acids during decomposition of organic manures which would have increased the availability of phosphorus and potassium, besides this, narrow C:P ratio might have accelerated the availability of phosphorus, organic acid produced during decomposition also tides Fe, Al and Mn, thereby increases the phosphorus availability. Besides, improved soil properties (Physical, chemical and biological) might also be responsible for enhanced nutrient availability. The increased nutrient availability with poultry manure/vermicompost as compared to other sources could be attributed to balanced C:N ratio, narrow C:P ratio, more organic carbon content and quick mineralization to available form.

The increase in nutrient availability in soil due to organics, their integration with inorganic sources of plant nutrients have also been reported by several workers (Reddy and Reddy, 1999; Shelke *et al*., 2001; Harkrishna *et al.,* 2002; Prabu *et al*., 2003; Dademal *et al*., 2004) in vegetable crops.

5.6 Economics

The results in Table-19 to 22 revealed net capital investment exhibited variation with different treatments in tomato cultivation. Maximum cost of cultivation Rs. 101427.20 was observed with T_5 (VC = 14 t ha^{-1}) followed by Rs. 85247.20 with T_3 (SM = 32 t ha^{-1}) followed by Rs. 83567.20 with T_{10}. The over all results indicate that capital investment varied with the level of technology. However, it does not convey that either a higher or lower investments in any treatment is responsible for higher returns.

Treatment T_4 (PM = 7 t ha^{-1}) registered highest net return of Rs. 314622.80 with return of 5.28 Re^{-1} invested followed by Rs. 282042.80 by T_3 (SM = 32 t ha^{-1}) with returns of 4.30 Rs^{-1} invested and Rs. 281622.80 with T_5 (VC = 40 t ha^{-1}) with return of 3.77 Re^{-1} invested. Thus among organic sources of plant nutrients T_4 proved more profitable interms of economic benefits. But one of the main objective of integrated nutrient management is sustainable agriculture in terms of improving soil health, fruit quality and overall production which are fulfilled by treatment T_9 followed by T_{10}. Even though it registered slightly lower returns (4.61 Re^{-1}) invested. Lowest net return of Rs. 907880.80 was observed with T_{12} (control). Similar trend has also been reported by Verghese (1996), Jhon (1997), Thronsbug *et al*. (2000).

CHAPTER – 6

SUMMARY AND CONCLUSION

Present investigation "Response of Shalimar Tomato Hybrid-I to Organic and Inorganic Sources of Plant Nutrients" was carried out at Experimental Farm Division of Olericulture, SKUAST-K, Shalimar during kharif-2009 and kharif-2010, with the objective of ascertaining the optimum level of organic and inorganic sources of plant nutrients for improvement in growth, yield and quality of Shalimar Tomato Hybrid-1 and to workout its impact on soil characteristics; OC, pH, EC, nutrient availability and on economics of production.

The experiment comprised of 12 treatments, was laid in Random Block Design (RBD) with three replications. Observation on growth, fruit yield, fruit quality and soil characteristics; OC, pH, EC and nutrient availability were recorded. The results obtained were statistically analysed and summarized as under :

- In general, it was observed that integration of organic with inorganic sources of plant nutrients exhibited a significant influence on all parameters under study over sole application of organic and inorganic sources.

- Treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) proved superior over rest of the treatments with respect to the improvement in the growth related attributes which is expressed in terms of plant height and number of branches $plant^{-1}$ followed by treatment T_{10} (7 t VC + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}).

- Treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) proved most effective with respect to improvement in the yield related attributes expressed in terms of number of fruits $plant^{-1}$, fruit size, average fruit weight and fruit yield ha^{-1} followed by treatment T_{10}.

- Treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) proved superior over rest of the treatments with respect to improvement in quality attributes expressed in terms of vitamin C content, TSS, lycopene content, protein content and acidity in fruit followed by T_{10} (7 t VC + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}).

- Treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) proved most effective in improving chemical characteristics of soil; OC, pH, EC and nutrient availability followed by T_{10} and T_8.

- Among sole application of organics, T_4 (PM = 7 t ha^{-1}) proved superior over rest of the individual organic sources with respect to growth, yield, fruit quality, soil characteristics and nutrient availability followed by T_5 and T_3.

- Sole application of inorganic sources of plant nutrients proved most effective than sole application of organic in most of the growth and yield related parameters.

- Maximum return of Rs. 314622.80 were recorded with T_4 (PM = 7 t ha^{-1}) followed by T_3, T_5, T_9 and T_2. Maximum returns (5.28 Re^{-1}) invested was registered with T_4 followed by 5.04, 4.61, 4.60 and 4.30 registered with T_6, T_9, T_1 and T_3, respectively.

Conclusion

In the light of the experimental results it can be concluded that, among different treatment combinations of inorganic and organic sources of plant nutrient treatment T_9 (3.5 t PM + 95 N: 75 P_2O_5 : 55 K_2O kg ha^{-1}) recorded significantly higher values of growth and yield attributing characters, the fruit quality attributes were also enhanced by this combination in Shalimar Tomato Hybrid-1, besides improvement in soil characteristics and nutrient availability followed by treatment T_{10}. The treatment wise cost of cultivation and their returns revealed maximum return of Rs. 314622.80 with maximum return of 5.28 Re^{-1} invested by treatment T_4 followed by T_3 and T_5.

The different parameters which includes; soil health, fruit yield, fruit quality and nutrient availability are fundamentals of sustainable agriculture and sustainable agriculture is one of the main objective of integrated nutrient management and these objective are satisfied in treatment T_9 and T_{10} therefore recommended for growing of Shalimar Tomato Hybrid-1.

LITERATURE CITED

Acharya, C.L. and Mandal, K.G. 2002. Integrated plant nutrient supply in vegetable crops, pp 79-104. **In: Compendium :** *Recent Advance in Vegetable Production Technology*: Proceedings of Winter School, 3-23 December, 2002, Varanasi, Indian Institute of Vegetable Research, Varanasi (UP).

Ahmad, S.R. 1993. Influence of composted coconut coir dust (coir peth) on soil physical properties, growth, yield of tomato. *South Indian Horticulture* **41** : 264-269.

Anonymous, 2008. National Horticulture Board, Area and Production of Vegetables for the year 2007-2008.

A.O.A.C. 1975. Official Method of Analysis Association of Official Analytical Chemists. Washington, D.C. 12th ed., pp. 1094.

Bhadoria, P.B.S., Prakash, Y.S., Amitva, R. and Rakshit, A. 2002. Importance of organic manures in improving quality of rice and okra. *Environment and Ecology* **20** : 628-633.

Bhardwaj, M.I., Harender, R. and Koul, B.L. 2000. Yield response and economics of organic sources of nutrients as substitute to inorganic sources in tomato (*Lycopersicon esculentum*), Okra (*Hibiscus esculentus*), Cabbage (*Brassica Olerecea Var. Capitata*) and Cauliflower (*Brassica Olerecea Var. Boirytis*). *Indian Journal of Agricultural Science* **70**: 653-656.

Bhattacharyya, P., Jain, R.K. and Paliwal, M.K. 2000. Bio-fertilizers for vegetable. *Indian Horticulture* **45 :** 12-13.

Chattoo, M. A., Ahmed N., Narayan S. and Faheema, S. 2003. Influence of organic manures on Cabbage Cv. Golden Acre, p. 94. **In: Souvenir:** *National Seminar on organic products and their future prospectus*, October 21-22, 2003, Srinagar SKUAST-K Shalimar Srinagar (J&K).

Chattoo, M. A., Ahmed, N., Narayan, S., Narayan, R., and Mir, S. A. 2003. Response of Garlic (*Allium Sativum L.)* to biofertilizer application, p. 93. **In: Souvenir:** *National Seminar on organic products and their future prospectus*, October 21-22, 2003 SKUAST-K Shalimar Srinagar (J&K).

Dademal, A.A. and Dongale, J.H. 2004. Effect of manure and fertilization on growth and yield of okra and nutrient availability in lateritic soils of Kon Kan. *Journal of Soil and Crops* **14** : 278-283.

Dademal, A.A., Dongale, J.H. and Uaskar, N.U. 2004. Effect of manures and fertilizers on content and uptake of nutrient by okra on lateritic soils of Kankan. *Journal of Soils and Crops* **14** : 262-268.

Dass, A., Lenka, N. K., Sudhirri, S. and Patnaik, U. S. 2002. Influence of integrated nutrient management on production economics and soil properties in tomato *(Lycopersicon esculentum L.). The Indian Journal of Agriculture Sciences* **78** : 40-43.

Erkossa, T., Stahr, K. and Tabor, G. 2003. Integration of organic and inorganic fertilizers : effect on vegetable productivity. *Journal of Soil and Water Conservation* **58** : 171-178.

Fisher, R.A. 1970. Statistical Method for Research Workers (14th Ed.). Oliver and Boagd, London, p. 356.

Gogoi, D., Kutoky, U. and Hazarika, S. 2004. Effect of biofertilizers on productivity and soil characteristics in banana. *Indian Journal of Horticulture* **61** : 354-356.

Gomez, K.A. and Gomez, A.A. 1984. *Statistical Procedure for Agricultural Research*. 2nd edition. John Wiley and Sons, Inc. New York.

Guthane, V.G. 2005. The effect of rhizobium and phosphorus solubilizers on nodulation, dry matter, seed protein, oil and yield of soybean. *Journal of Soils and Crops* **15** : 132-135.

Harikrishna, B.L., Chamnal, H.T., Hebsur, N.S., Dharmati, P.R. and Sarangmath, P.A. 2002. Yield and economic analysis of tomato. *Karnataka Journal of Agricultural Sciences* **15** : 373-374.

Harikrishna, B.L., Chaunal, H.T., Hebsur, N.S., Dharmati, P.R. and Sarangamath, P.A. 2002. Integrated nutrient management on quality ability of nutrients, uptake and yield of tomato. *Karnata Journal of Agricultural Sciences* **15** : 275-278.

Hori, K., Fukunaga, A., Vrashwne, Y., Suga, Y. and Ikeda, J. 2002. Soil chemical characteristics of organic farming vegetable fields. *Bulletin of the National agricultural Research Leisure for Western Region* **1** : 77-94.

Jachimaiwiez, Th. 1941. Vitamin C in paprika. *Biochemische Zeischrift* **307** : 387-399.

Jackson, M.L. 1973. Soil Chemical Analysis. Prentice Hall of India Pvt., New Delhi.

Jhon, 1997. Studies on efficacy of biofertiliaers and organic manures with different levels of nitrogen on growth, yield and quality of brinjal (*Solanum melangena* L.). M.Sc thesis submitted to Jawahar Lal Nehru Krishi Vishwavidyalaya, Jabalpur, M.P.

Jose, D., Shamugavelu, K. G., and Thumburaj, S. 1988. Studies on the efficiency of organic Vs inorganic form of nitrogen in brinjal. *Indian Journal of Horticulture* **45** : 100-103.

Juroszek, P., Lumpkin, H.M., Ledesma, D., Yang, R.Y. and Ma, C.H. 2007. Comparison of plant vigour, fruit yield, lycopene and other physiochemical in tomatoes grown under in conventional vs. organic management systems. Final Project Report, Unpublished, 76 pp.

Kaistha, B.P., Sharma, P.C. and Dubey, Y.P. 1997. Influence of organic manures and fertilizer phosphorus addition on available organic and total phosphorus in an acid alfisol. *Himachal Journal of Agricultural Research* **23** : 21-26.

Kamili, I.A., Zargar, M.Y. and Chatoo, M.A. 2002. Effect of microbial inoculants, chemical nitrogen and their combination on brinjal (*Solanum melangena* L.). *Vegetable Science* **29** : 87-89.

Kolte, U. M. Patil, A. S. and Tumbare, A. D. 1999. Response of tomato to different nutrient inputs and irrigation. *Journal of Maharashtra Agricultural Universities* **24** : 4-8.

Magray, G. H. 2002. Effect of organic and inorganic fertilizers on growth, yield and quality of capsicum (*Capsicum annum L.*). M. Sc Thesis submitted to SKUAST-K Shalimar Srinagar, p. 56.

Mahendran, P.P. and Kumar, N. 2001. Effect of organic manure on cabbage cv. Hero (*Brassica oleracea* var. capitata L.). *South Indian Horticulture* **45** : 240-243.

Malewar, G. U., Ismail, S. and Rudraksha, G.B. 1998. Integrated nitrogen management in Chilli (*Capsicum annum L.*). *Bulletin of Indian Institute of Soil Science* **2** : 156-163.

Malik Ajaz, A., Chatoo, M.A., Dar, M.A., Habib, K. and Qadir, S. 2009. Effect of integrated nutrient management on Growth and Yield attributing characters of Capsicum Hybrid SH-SP-5. *SKUAST Journal of Research* **11** : 90-95.

Manolikar, R.R., Vikar, M.N., Vasmate, S.D., Patil, R.F. and Kalal bandi, B. M. 2004. Effect of integrated nutrient management on growth and yield of tomato (*Lycopersicon esculentum Mill.*). *The Asian Journal of Horticulture* **2** : 178-180.

Maynard A. A. 1994. Sustained vegetable production for three years using composed annual manure. *Compost Science and Utilization* **2**: 88-96.

Maynard, A.A. and Lorenz, O.A. 1970. Seventy five years of progress in the nutrition of vegetable crops. *Horticultural Science* **14**(3) : 353-358.

Merwin, H.D. and Peech, M. 1950. Exchangeable soil potassium in the sand, silt and clay fractions as influenced by the nature of complementary exchangeable cations. *Soil Science Society of American Journal* **15** : 125-128.

Naidu, A.K., Khushwah, S.S., Mehta, A.K. and Jain, P.K. 2001. Study of organic, inorganic and bio-fertilizers in relation to growth and yield of tomato. *JNKVV Research Journal* **35** : 36-37.

Narayan, R.N., Magray, G.H., Ahmad, N. and Samaura, A. 2004. Effect of organic manures on nutrient uptake and quality of capsicum. *The Horticulture Journal* **17** : 141-144.

Numbiar, K.K.M. and Abrol, I.P. 1989. Long term fertility experiment in India. *Fertilizer News* **34**(4) : 11-12.

Olsen, S.R., Coleman, C.W., Watnabe, F.S. and Dean, L.A. 1954. Estimation of available phosphorus with sodium bicarbonate.*United States Department of Agriculture Circular* **939** : 19.

Patil, M.P., Hulamani, N.C., Athani, S.I. and Patil, M.G. 1998. Response of new tomato genotype Megha to integrated nutrient management. *Advance in Agricultural Research in India* **9** : 39-43.

Perumal, K., Chakrapathy, K. andVatsala, T.M. 2003. Influence of nutrient management on quality and yield of carrot. *Journal of Soils and Crops* **13** : 204-210.

Piven, P.Y., Grishkevich, M.I., Karyagiva, L.A., Mikhailovskaya, N.A. and Mooroz, G.V. 1987. The influence of fertilizers on the productivity of vegetable crops in rotation and on the biological activity of dernopodzolic soil. *Agrokhimiya* **2** : 49-53 [cf : CAB Abstracts 1987-1989].

Prabakaran, C. and Pitchai, J.G. 2002. Effect of different organic nitrogen sources on pH, total soluble solids, titrable acidity, reducing and non-reducing sugars, crude protein and ascorbic acid content of tomato fruits. *Journal of Soils and Crops* **12** : 160-166.

Prabhu, M., Veeraragavathatham, D., Srinivasu, K., Pingaleudni, L. and Rajangan, J. 2004. Studies on the uptake of nutrients by brinjal hybrid COBH-1. *South Indian Horticulture* **52** : 122-127.

Premsekhar, M. and Rajashree, V. 2009. Influence of biofertilisers on growth characters, yield attributes, yield and quality of tomato. *Am-Eurasian J. Sustain. Agric*. **3** : 68-70.

Rafi M., Narwad Kar, P. R., Prabu I. and Sajondranath A. K. 2001. Effect of organic and inorganic fertilizers on yield and quality of tomato (*Lycopersicon esculentum Mill.*). *Journal of Soils and Crops* **12** : 167-169.

Raj, A. K and Kumari, V. L. G. 2001. Effect of organic manures and Azospirrilium inoculation on yield and quality of Okra *(Abelmoschus esculentus L. Moench) Vegetable Science* **28** : 179-181.

Rangana, S. 1986. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. 2nd edition. Tata McGraw Hill, New Delhi.

Ray, R., Patra, S.K., Ghosh, K.K. and Shaoo, S.K. 2005. Integrated Nutrient Management in Okra in a river basin. *Indian Journal of Horticulture* **62** : 260-264.

Reddy, G.B. and Reddy, M.S. 1999. Effect of integrated nutrient management on soil available micro-nutrients in maize soyabean cropping system. *Journal Research ANGRAU* **27** : 24-28.

Reddy. C. S., Narayanamma, M., Chiranjeevi, c. and Reddy, I. P. 2002. Effect of nutrient sources on the fruit yield of tomato. *Vegetable Science* **29** : 193-194.

Renuka, B. and Sarkar, C.R. 2001. Effect of organic manures on growth and yield of tomato. *South Indian Horticulture* **49** : 216-219.

Samawat, S., Lakzian, A. and Zamirpoor, A. 2001. The effect of Vermicompost on growth characterization of tomato. *Agricultural Sciences and Technology* **15**: 83-89.

Sengupta, S.K., Divivedi, Y.C. and Kushwah, S.S. 2002. Response of tomato to bioinoculants at different levels of nitrogen. *Vegetable Science* **29** : 186-188.

Shelke, S.R., Adule, R.N. and Amrutsagar, V.M. 1999. Nitrogen management through organic and inorganic in brinjal. *Journal of the Indian Society of Soil Science* **49** : 505-508.

Singh, A.K., Gupta, M.J., Srivastava, R. and Behera, T.K. 2005. Effect of NPK levels on growth and yield of tomato hybrids under multi-span polyhouse. *Indian Journal of Horticulture* **62**(1) : 91-93.

Singh, B., Singh, N. and D. V. 2000. *Prospectus of vegetable production in Ladakh*, pp. 85-98. **In:** Dynamics of Cold Arid Agriculture (Eds J. P Sharma and A. A. Kalyani Publisher New Delhi).

Singh, K.., Minhas, M.S. and Srivastava, O.P. 1973. Studies on poultry manure in relation to vegetable production 11. Potato. *Sudian Journal of Horticulture* **30** : 537-541.

Singh, R. and Asrey, R. 2005. Integrated nutrient management in tomato (*Solanum lycopericon* L.) under semi-arid conditions of tomato.

Singh, S. R., Prakash S. and Kumar J. 2000. Organic farming technology for sustainable vegetable production in Himachal Pradesh. *Himachal Journal of Agricultural Research* **26** : 69-73.

Subbiah, B.V. and Asija, J.S. 1956. A rapid procedure for the estimation of available nitrogen in the soil. *Current Science* **25** : 259-260.

Subehia, S.K., Verma, S. and Sharma, S.P. 2005. Effect of long term use of chemical fertilizers with and without organics on forms of soil acidity, phosphorus adsorption and crop yields in an acid soils. *Journal of the Indian Society of Soil Science* **53** : 308-314.

Swain, A.K; Pattanyak, S.K; Jena M. K and Nayak, R. K 2003. Effect of Integrated use of bio-inoculants and fertilizer nitrogen on growth, yield and nitrogen economy of Okra- *Journal of the Indian Society of Soil Science* **51**: 145-150.

Tandon, H.L.S. 1993. Methods of Analysis of Soil, Plant, Water and Fertilizer. Fertilizer Development and Consultation Organisation, New Delhi.

Thornsbug, S.D., Stoffela, P.J. and Minton, T.M. 2000. Economics of organic waste compost utilisation in commercial tomato production system. *Acta Horticultuae* **536** : 93-99.

Umar, I. and Jada, M.Y. 2000. The efficacy of mixture of two organic amendments (Parkia seeds and goat manure) on the control of root knot nematode on tomato. *Global Journal of Pure and Applied Science* **6** : 177-180.

Vavilov, N. I. 1951. The origin, variation immunity and breeding of cultivated plants. *Chemical Botany* **1**(6) : 364.

Verghese, 1996. Study on integrated nutrient management in cabbage cv. Pride of India. M.Sc thesis submitted to Jawahar Lal Nehru Krishi Vishwavidyalaya, Jabalpur, M.P.

Walkley, A. and Black, J.A. 1934. An estimation of the method for determining soil organic carbon and a proposed modification of the chemical and tritration method. *Soil Science* **37** : 29-39.

Wang, H., Zheng, G.H. and Ma, B.A. 1992. Application of sterilized chicken manure in soil leaves cultivars of tomato. *Chinese Vegetable* **3** : 31-32.

Wani, A.J. 2006. Effect of organic manures and inorganic fertilizers on growth and yield of cauliflower (*Brassica oleracea* var. botrytis L. cv. Snowball-16). M.Sc thesis submitted to Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shalimar, Srinagar.

Wong, J.W.C., Ma, K.K., Fang, K.M. and Chang, L. 1999. Utilization of manure compost for organic farming in Hong Kong. *Bioresources Technology* **67** : 43-46.

Xu, H. L., Wang R., Xu, R. Y. Mridha, M. A. U, Goyal, S. and Tremblay, N. 2003. Yield and quality of leafy vegetables grown under organic fertilization. *Acta Horticulture* **627**: 25-33.

APPENDIX-I

Agrometeorological Data of 2009 and 2010 at Experimental Farm, Shalimar

Month/Year	Temperature (^oC)		Relative humidity (%)		Rainfall (mm)
	Maximum	Minimum	Maximum	Minimum	
April, 2009	19.91	6.93	79.30	51.73	2.71
May, 2009	24.94	8.96	74.22	51.72	1.64
June, 2009	26.22	11.37	72.53	47.23	2.22
July, 2009	29.71	14.94	81.04	50.16	1.55
August, 2009	31.55	16.45	76.41	49.25	1.15
September, 2009	28.94	10.19	83.7	47.10	0.90
October, 2009	22.70	3.55	86.16	45.12	0.06
Mean	**22.03**	**10.34**	**79.5**	**48.81**	**1.46**
April, 2010	20.83	6.48	86.46	54.60	3.36
May, 2010	21.91	9.82	83.35	59.32	5.49
June, 2010	25.16	10.78	83.46	61.10	1.18
July, 2010	26.72	15.36	75.83	55.29	1.90
August, 2010	28.51	17.63	87.00	62.29	4.77
September, 2010	27.20	12.15	86.14	56.78	7.52
October, 2010	23.77	5.50	89.74	61.96	1.09
Mean	**24.87**	**11.10**	**84.50**	**58.76**	**3.61**

<u>**APPENDIX – II**</u>

Nutrient composition of organic and inorganic fertilizers used

Source	**Nutrient composition (%)**		
	N	**P_2O_5**	**K_2O**
Farm yard manure (FYM)	0.50	0.39	0.28
Sheep manure (SM)	0.60	0.46	0.34
Poultry manure (PM)	2.80	2.14	1.57
Vermi compost (VC)	1.40	1.07	0.78
Biofertilizers			
Azospiillum	Assumed to substitute 50% N		
Phosphobacteria	Assumed to substitute 50% P		
Inorganic			
Urea	46.00	-	-
DAP	18.00	46.00	
Muriate of potash	-	-	60.00

APPENDIX – III

Whole sale rate of tomato

Organic	Rs. 1000.00 q^{-1}
Inorganic	Rs. 600.00 q^{-1}

APPENDIX – IV

Purchase rates of organics and inorganic fertilizer

Source	Rate (Rs. t^{-1})
Farm yard manure (FYM)	500.00
Sheep manure (SM)	800.00
Poultry manure (PM)	2000.00
Vermicompost (VC)	3000.00
Biofertilizer	40000.00
Urea	5780.00
Diammonium phosphate	10450.00
Murate of potash	6000.00

Sher-e-Kashmir
University of Agricultural Sciences & Technology of Kashmir
Division of Olericulture
Shalimar Campus, Srinagar – 191 121
-::o::-

CERTIFICATE

Certified that all the corrections/amendments as suggested by External Examiner Dr. S.R. Singh, Senior Scientist, CITH, Rangreth, Srinagar during Viva-Voce examination held on March 5th, 2011 have been incorporated in the manuscript entitled **"Response of Shalimar Tomato Hybrid-1 to Organic and Inorganic Sources of Plant Nutrients"** submitted by **Mr. Mohammad Mudasir Magray (Regd. No. 2008-A-822-M)**.

Dr. M. A. Chattoo
Chairman
Advisory Committee