INVESTIGATION ON SEED YIELD AND QUALITY AS INFLUENCED BY ORGANICS IN CAPSICUM (*Capsicum annuum*)

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C O N T E N T S

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LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

1. INTRODUCTION

Capsicum (*Capsicum annuum*) belongs to the family Solanaceae. It is also called as sweet pepper, bell pepper or green pepper. It differs from common hot pepper in size, shape of the fruits, capsaicin content and usage.

Chillies, green or red fruits of *Capsicum annuum* L. belongs to the family Solanaceae. Chillies are native of Peru and Mexico and Portuguese were the first to introduce chillies in India during 15th century. Its cultivation became popular in the 17th century. Though chilli is an introduced crop in India, due to its suitable growing climate, India stands first in chilli cultivation in the world covering 45 per cent of the total hectarage (Reddy and Sadashiva, 2001).

Nutritionally, it is rich in vitamins particularly, vitamin A and vitamin C. Hundred gram of edible portion of capsicum provides 24 k cal of energy, 1.3 g of protein 4.3 g of carbohydrate and 0.3 g of fat (Anon., 2001).Bell pepper is one of the most popular and highly remunerative vegetable crops grown throughout the world. The countries where capsicum are grown as major vegetable crop in China, Mexico, Spain, Romania, Italy, Yugoslovia, Bulgaria, USA, Hungary, India, Hong Kong and other European, Central and South America countries. In India, it is a high value crop and is intensively cultivated in Karnataka, Maharashtra, Tamil Nadu, Himachal Pradesh and in hilly areas of Uttar Pradesh.

In the world, area and production of bell pepper is merged with that of hot pepper (chilli pepper) and hence exact statistics on its area and production is not available. Annual world production of bell pepper in the year 2007 amounted to 23 million metric tonnes from an area of 1.54 million ha. China is the major producer of capsicum with an area of 0.61 million ha with a production of 120 million tonnes. India's contribution was estimated to he 50,500 thousand tonnes from an area of 5,500 thousand hectares (Anon., 2004). Karnataka has an area of 3,097 ha with a production of 34,931 tonnes. Bangalore (663 ha), Belgaum (517 ha), Mandya (464 ha) and Kolar (460 ha) districts of Karnataka possess highest area under this crop (Anon., 2003). The consistent efforts are being made to reduce the flower and fruit drop in chilli by spraying NAA (Hariharan and Unnikrishnan, 1983 and Lata and Singh, 1993).

Bell pepper occupies a pride place among the vegetables, for its delicious taste and pleasant flavour. In India, bell pepper is mainly grown for its fruits which are used prior to its maturity in various culinary preparations and also stuffings in pizza and burger. It imparts delicious taste and pleasant flavour to the cuisine.

Bell pepper has attained the status of a high value crop in India during recent years. The high market price, it is attributed to the heavy demand from the urban consumers and even a small blemish on the fruit will drastically reduce its market value. Under these circumstances, insect pests which reduce the fruit quality are important.

Organic farming has assumed importance as an offshoot of environmental concerns in the Western World. The almost total dependence on chemical fertilizers, pesticides, herbicides and growth regulators for enhancing crop productivity gradually culminated in a situation where in need to reconsider the alternative for chemical agriculture gradually developed in the Western World. It is a well documented fact that increased dependence on agro-chemicals including fertilizers has led to several ill effects on the environment.

There has been great competition in the world market for capsicum and hence, there is need to improve the crop with respect to production and quality. Seed is basic and crucial input in agricultural crop production. The most important aspect is maintaining continuous supply of high quality seed to growers, to produce physically and genetically pure seeds and to preserve the qualities of seeds from harvest to next sowing. The quality of seed either for seed multiplication or for general cultivation depends on several factors which influence the planting value of seed. The high quality of seed in terms of viability and vigour are the essential factors which determine the seedling development in nursery and plant establishment in the field to get higher yield with high quality seed (Doijode, 1988). Production of high quality seed is possible only by adopting scientific, cultural and improved agronomic management practices. Among several agronomic and management practices, the mother

plant nutrition plays an important role for increasing production of quality seed. Seed yield and quality are known to vary with nutrient status of the soil and plant characters.

Organic agriculture cannot be adopted uniformly under all farming situations. The technology has a role to play in the cultivation of high value crops, fruits, vegetables, spices, and condiments, medicinal and aromatic plants. The organically cultivated food crops have a vast untapped export potential growing at 10-15 per cent per year. The sustainable agricultural practice can effectively prevent entry of pesticides and toxicants in the food chain and prevent soil water pollution and health hazards, It also adopted with a blend of ecologically sale modern technologies, organic agriculture, though not in its orthodox version, has the potential to be accepted by the farmers. Theoretically organic agriculture is the most ideal system of farming.

India is the largest producer, exporter and consumer of spices in the world .Of the total, 90 per cent of spices produced in the country is used to meet the domestic consumption and, only 10 per cent is exported. Organic spices fetch 20-50 per cent higher price than inorganic spices. India has its own strength in intrinsic quality of spices and low consumption of fertilizers and pesticides which can exploit the commercial agriculture. India enjoys the monopoly in the export of spice oils and oleoresins with a contribution of 20 per cent of total export quality and 24 per cent of the total export earnings from spices.

Risk to health from eliminating fruit and vegetables from the diet would outweigh the risks posed by possible exposure to pesticide residues. The data from various sources undoubtedly indicate the drastic reduction of pesticide residues contamination in inorganic foods. In the last few decades, awareness on health consciousness lead to organically produced food stuffs. The tremendous demand for organically produced food has led to the creation of new export avenues for developing countries. Organic farming is a holistic production management system which involves the use of organic manures, botanical pesticides and biological pest control strategies that can act as an alternative to the costlier, non-ecofriendly and energy intensive chemical inputs.

Although chemical fertilizers are playing a crucial role in meeting the nutrient requirement of the crop, persistent nutrient is posing a greater threat to sustainable agriculture.

Vermicompost, is commonly used as organic manure which is rich in both macro and micronutrients, besides having plant growth promoting substances, humus forming microbes and nitrogen fixers (Bano and Kale, 1987). Recently, it has been found that the use of vermicompost in vegetables (Huang and Zhao, 1987), flowering plants (Kale *et al*., 1987) and field crops has increased the yields both in terms of quantity and qualitatively and relatively less disease and pest incidence.

Neem cake is the important by product obtained after extraction of oil from kernel which has pest suppressing character. This may be attributed primarily to certain phenolic compounds released during decomposition apart from stimulatory effect on root growth.

Capsicum crop is cultivated both in protected and unprotected conditions. Information available on organic capsicum production is very limited. Hence, an attempt has been made to investigate organic seed production with the following objectives.

Objectives

1. To study the effect of soil application of organics on growth, seed yield and seed quality of capsicum
2. To study the effect of foliar application of organics on growth, seed yield and seed quality of capsicum
3. To study the interaction effect of soil application and foliar application of organics on growth, seed yield and seed quality of capsicum
4. To study the economics of organic seed production
5. To study the comparative economic analysis of organic seed production with inorganic seed production in capsicum

2 REVIEW OF LITERATURE

Capsicum crop responds well to the application of both organic manures and inorganic fertilizers. Of late, bio-fertilizers are gaining importance because of their low cost, no residual toxicity and capacity to enrich soil fertility in addition to high returns under favourable conditions. There is greater demand in the international market for organically produced capsicum. Organic manures supply the major nutrients, micronutrients, besides improving soil health. The application of organics has also been shown to increase ascorbic acid content in chilli, which is one of the important quality parameters.

The literature pertaining to use of only organics (farmyard manure, vermicompost, biofertilizer and neem cake) on growth, yield and quality of capsicum are very scarce, so the combined effect of organics on capsicum as well as on few of the related crops have been reviewed and presented in this chapter.

2.1 CONCEPT OF ORGANIC FARMING

Organic farming is a production system which avoids or largely excludes the use of synthetically produced fertilizers, pesticides, growth regulators and livestock feed additives. To the maximum extent possible organic farming system relay upon crop rotations, crop residues, animal manures, legumes, green manures, off farm organic wastes, mineral bearing rocks and biofertilizers to maintain soil productivity and to supply plant nutrients and biological means to control insects, weeds and other pests.Organic farming is both a philosophy and a system of agriculture. The objects of environments, social and economic sustainability found a place at the heart of organic farming and are among the major factors determining the acceptability or otherwise of specific production practices (Stockdale *et al.*, 2001).

2.1.1 Farmyard manure (FYM)

Manurial value of FYM

The nutrient content of FYM varies with the constituents/ composition of FYM. Chatterjee *et al.* (1979) reported nutrient content of FYM was found to be 0.64 per cent N, 0.07 per cent P and 0.29 per cent K. Whereas, Sharma and Mitra (1989) recorded that FYM having 26.1 per cent of C, 1.71 per cent N, 0.24 per cent P and 2.04 per cent K on dry weight basis. The C:N ratio was 15:1 and the nutrients added from 2.5 t FYM were 42.7, 5.9 and 51.1 kg N, P and K per ha.

The farmyard manure seems to act directly by increasing the crop yield either by accelerating the respiratory process through cell permeability or by harmone growth action. It supplies nitrogen, phosphorus and sulphur in available form to the plants through biological decomposition. Indirectly, it improves the physical properties of soil such as aggregation, aeration, permeability and water holding capacity (Chandramohan, 2002).

Subramanian *et al.* (2000) opined that the inclusion of organic manures *viz.*, FYM and sunhemp in the fertilizer schedule not only increased the yield but also improved the soil moisture storage at 31, 31.2 and 31. 4 per cent at 0-15,15-30 and 30-60 cm soil depth, respectively.

Effect of FYM on growth and yield components

Organic manures like farm yard manure (FYM) seems to act directly in increasing crop growth and yields either by accelerating respiratory process with increasing cell permeability and hormonal growth action or by combination of all these process which supplies nitrogen, phosphorus and sulphur in available form to the plants through biological decomposition and improves physical properties of soil such as aggregation, permeability and water holding capacity (Purakayastha and Bhatnagar, 1997).

A brief review of literature on the effect of FYM on capsicum crop is given below. Damke *et al.* (1988) observed greater plant height (60.3 cm) and yield in chilli (1.52 t/ha) with application of FYM at 9 t per ha along with 50:50:50 kg of N, P_2O_5 and K_2O per ha. Surlekov

and Rankov (1989) reported greater plant height (58.6 cm) and number of branches of (4.2) with the application of farmyard manure at 20 t per ha along with 100:80:100 kg N, P_2O_5 and K_2O per ha in capsicum.

Natarajan (1990) reported maximum plant height (65.5 cm) and number of branches per plant (10.1) in chilli when FYM was applied at the rate of 25 t per ha along with 75:35:35 kg NPK per ha compared to inorganic fertilizers alone (56.7cm and 8.93). Application of FYM (15 t/ha) + 150:100:50 kg NPK per ha recorded significantly higher plant height (73.21 cm) and number of branches (62.01/plant) as compared to different fertilizer levels in tomato cv. Co-3. Sendurkumaran *et.al*., (1998). Nirmala and Vadivel (1999) noticed significantly less number of days to appearance of first female flower (30) and narrow sex ratio (6:1) with the application of FYM (30 t/ha) along with 35 kg nitrogen per ha as compared to FYM and nitrogen applied individually in cucumber. Sutagundi (2000) reported that early flowering (43.66 days) was recorded in plant receiving FYM (10 t/ha) as compared to 100:50:50 kg NPK per ha (43.75 days) in chilli. According to Mallanagouda *et al.* (1995) the application of recommended dose of NPK (100:80:80 kg per ha) + FYM (10 t per ha) improved the growth parameters, yield (2099 kg/ha) and yield components of chilli. An experiment conducted at Agriculture Improvement Station, Taiwan on chilli has shown that plant height was significantly higher with organic manures than chemical fertilizers (Hsieh-Ching Fung *et al.*, 1994). The application of organics viz., FYM, chilli stalks and FYM +chilli stalks with inorganic fertilizers (RDF) significantly influenced the growth, yield, nutrient uptake and quality of chilli and the magnitude of combined effect of organic and inorganics was higher than inorganics alone (Kattimani, 2004).. Renuka and Ravisankar (2001) reported that integrated application of FYM (15 t/ha) with NPK (120:70:70 kg/ha) resulted significantly higher number of branches (3.66) as compared to their individual application in tomato.

2.2 YIELD AND YIELD COMPONENTS

Narasappa *et al.* (1985) reported that the application of 150 kg N + 10 t FYM per ha increased the green chilli yield by 60.42 per cent over the control. The higher level of fertilizer application of N, P_2O_5 and K_2O at 60 kg per ha each with FYM produced higher yield of capsicum (12.20 q/ha) as compared to without FYM (9.81 q/ha) (Doikova *et al.*, 1986). Natarajan (1990) reported that higher fruit yield of chilli (1.83 t/ha) when FYM 25 t/ha was applied as basal dose along with 75:35:35 kg NPK per ha. Patil and Biradar (2001) recorded the highest dry chilli (19.12 q/ha) when applied with 200 per cent of RDF + FYM + vermicompost compared to 100 per cent of RDF + FYM (13.86 q/ha) alone. Nair and Peter (1990) revealed that, the application of high rates of both organic (15 t/ha FYM) and inorganic fertilizers (175:40:75 kg NPK/ha) increased the fruit yield during all the three seasons. Chavan *et al.* (1997) recorded higher fruit yield (1975.30 kg/ha) with application of 75 kg N per ha + FYM @7.5 t per ha, which was significantly higher than control (1076.50 kg/ha) in chilli.

Rao *et al.* (1997) found that fruit yields from the plants grown in plots amended with compost was 30.3, 35.7 and 31.1 t per ha in control plots, 50 per cent and 100 per cent recommended dose of fertilizer (RDF) as compared to the yields of 19.8, 31.1 and 32.0 t per ha respectively with control, 50 per cent and 100 per cent RDF without compost in chilli. Naidu *et al.* (1999) observed higher number of fruits per plant (24.3) and fruit yield (149 q/ha) with the application of 80:60:50 kg NPK per ha in addition to 20 t FYM per ha. It was significantly superior over control (17.3 and 100 q respectively) in okra. Duraisamy *et al.* (1999) reported significantly higher fruit yield of 12.44 t per ha with the application of 96:77:70 kg NPK with 12.5 t FYM per ha in tomato cv. Paiyur-1 as compared to other fertilizer levels.

Nirmala *et al.* (1999) recorded significantly higher fruit length (15.53 cm), fruit girth (11.79 cm), fruit number (9.71/vine) and fruit yield (1435.1 g/vine) with application of FYM (30 t/ha) + N (35 kg/ha) as compared to other manurial treatments in cucumber. Application of 100:100:100 kg NPK per ha and 12.5 t FYM per ha recorded significantly higher fruit yield (26.8 t/ha) compared to 75:75:100 kg NPK per ha alone (20.1 t/ha) in brinjal (Nanthakumar and Veeraragavatham, 2001).

Rekha and Gopalakrishnan (2001) stated that the longest (26.7 cm) and thickest (17.5 cm) fruits were recorded by FYM (25 t/ha) with inorganic fertilizers (70:25:25 kg

NPK/ha) in bitter gourd. Shashidhara (2000) reported that application of FYM (5 t per ha) + RDF (100:50:50 kg NPK per ha) significantly influenced the yield (794.08 kg per ha) and yield attributes of chilli as compared to the application of inorganic fertilizer (629.15 kg/ha) alone.

Suresh (2000) reported that, combined application of RDF (100:50:50 kg NPK per ha) + FYM produced significantly higher dry chilli fruits as compared to RDF alone (11.28 q/ha)

Malawadi (2003) found that application of NPK (100:50:50) + FYM (10 t per ha) recorded significantly higher dry chilli fruit yield (844.39 kg per ha) over NPK alone (695.46 kg per ha) and growth and yield components of chilli were also significantly higher with the application of NPK + FYM.

Application of organics *viz.*, FYM @ 10 t per ha along with 100 per cent RDF resulted in higher fruit yield (919 kg/ha) as compared to RDF alone (781 kg/ha) (Kattimani, 2004).

Sankaranarayanan *et al.* (1995) reported effect of *Azospirillum* on improved varieties of bhendi. *Azospirillum* + 50 per cent N recorded the highest root length (8.12 cm), plant height (63.99 cm), number of fruits (33.44) and yield per plant (217.14 g) in bhendi.

Paramasivan *et al.* (2003) assessed the effect of organic manures and inorganic fertilizers on yield and economics of okra. The treatment FYM @ 25 t/ha + CCP (composted coir pith) @ 12.5 t/ha + vermicompost (1.5 t/ha) + 40:50:300 kg per ha NPK recorded maximum number of branches (3.5), early in days to 50 per cent flowering (45.4) and maximum number of fruits per plant (9.9).This was due to integration of organic and inorganic nutrients resulting in better translocation of nutrients under optimum moisture condition of soil leading to availability of nutrients and increased photosynthetic activity *etc.*

Duraisamy *et al* (1999) studied the effect of fertilizer nitrogen, *Azospirillum* and organics on yield and nutrition of rainfed tomato. Biofertilizer/organics and coconut coir pith (CCP) accounted the highest fruit yield (14.68 t/ha) followed by FYM (12.44 t/ha). Positive effect of coir pith on the yield might be due to the better physical conditions and nutrient availability to crop.

Kamla Singh (2001) reported that effect of biofertilizer and nitrogen under north-eastern hill condition combined inoculation of *Azatobacter* and *Phosphobacteria* inoculant culture together significantly increased tuber yield, plant height (225.3 g/hill, 47.3 cm), respectively. It indicates the biofertilizer increased the efficacy of applied nitrogen and its efficiency.

Govindarajan *et al.* (1998) reported *Azospirillum* a potential inoculant for horticultural crops among the free living nitrogen fixing bacteria. It contributes significant amount of nitrogen to the plants there by saving valuable nitrogenous fertilizer. It improved root development, mineral uptake and plant water relationship.

Sundaravelu *et al.* (1993) assessed the effect of seed treatment with *Azospirillum* and gibberellic acid on the growth and yield of radish. Application of *Azospirillum* in combination with GA_3 induced the vegetative growth at a faster rate growth of leaves. The root length, diameter and weight were increased due to *Azospirillum* in combination with treatment, root length (29.83 cm), root diameter (3.97 cm), weight (55.06 kg per plot). This is mainly due to enhance the total number of leaves and leaf length.

Paramaguru *et al.* (1993) studied the effect of *Azospirillum* on growth and yield of chilli. *Azospirillum* + 56 kg N per ha recorded the highest plant height of 56.13 to 57.86 cm. *Azospirillum* recorded the highest yield of 2.45 t per ha. Increased in the yield and growth parameters due to production of more lateral roots, more symbiotic activity could have taken place and nitrogen fixed which resulted in increased yield.

Dubey (2001) reported that association effect of nitrogen fixing and phosphate solubilzing bacteria in soybean. Super phosphate (26.4 kg) + PSB recorded higher seed yield . The increased yield was due to the maximum efficiency of phosphate solubilizing bacteria and its post efficiency was also observed.

Bodamwad *et al.* (2006) assessed the effect of organic and inorganic fertilizer on seed quality and seed yield of okra cv. Parbhani Kranti. The maximum fruit weight (5.92 g), seed weight (3.01 g), 1000 seed weight (59.30 g), higher germination (93.34%) were observed in 50 per cent RDF + 50 per cent neem cake. Higher weight of 1000 seeds and germination percentage may be due to more availability of nitrogen in the soil for longer duration as neemcake reduces the leaching losses. There is more availability of nitrogen for prolonged period.

Balasubramanian *et al.* (1997) studied the effect of *Azospirillum* and nitrogen on growth, flowering fruits yield and quality of bhendi cv. Pusa Sawani. Seed and soil treatment with the application of *Azospirillum* with 30 kg N per hectare recorded the highest plant height (205.2 cm) the increased plant height was an important parameters of vigorousness and highest fruit yield (315 g/ plant) and per hectare highest yield of (17.5 tonnes).

Natarajan *et al.* (2003) reported the influence of growing media, irrigation regime, integrated nutrient management and mulching on yield and economics in tomato hybrids under polyhouse condition. Treatment consisting of RDF+ biofertilizer as basal registered higher yield per hectare (165 t). Increased fruit yield was ascribed to the supplementation of nitrogen and phosphorus requirement of the crop by *Azospirillum* and *Phosphobacterium.*

2.3 EFFECT OF FYM ON SEED YIELD AND QUALITY PARAMETERS

Sutagundi (2000) noticed significantly higher 100 seed weight (0.6 g) with the application of FYM (10 t/ha) along with NPK (100:50:50 kg/ha) as compared to their individual application in chilli. Shashidhara (2000) reported higher seed weight (5.84 g) by applying FYM (5 t/ha) + 50 per cent RDF compared to 50 per cent RDF alone (5.02 g) in chilli.

2.4 EFFECT OF FYM ON NUTRIENT STATUS AND SOIL PROPERTY

Dhiman *et al.* (1998) reported that application of FYM @10 t ha^{-1} + 100 per cent recommended N increased the organic carbon content. Incorporation of organic manures in the form of FYM and crop residues increased the organic matter content of the soil (Thakur *et al.*, 1999). Maheswarappa *et al.* (1997) observed that, organic carbon content was increased to a greater extent at 0.25 m depth with FYM and vermicompost application than other organic sources. Radhamadhav *et al.* (1999) observed that incorporation of FYM in field crops improved the phosphorus status of the soil through slow decomposition of FYM.

The beneficial effects of FYM on various physico-chemical properties of soil and to sustain higher yield levels were also reported by Sudhakar (2000).

Katkar *et al.* (2002) in cotton reported that, the treatments with FYM, bio-mulching, green foliage lopping of glyricidia and sunhemp manuring in greengram resulted in increased organic carbon content in the soil from 1.72 to 3.92 per cent.

2.5 VERMICOMPOST

Manurial value of vermicompost

The complex organic residues are biodegraded by symbiotic association between earthworm and microbes during this process vermicompost or vermicastings are produced. The vermicast apart from increasing the density of microbes also provides sufficient energy for them to remain active. Vermicasting can provide the required nutrients to the plants. It provides the vital macro elements such as N, P_2O_5, K_2O, Ca and Mg and micronutrients such as Fe, Mo, Zn, Cu etc. The chemical analysis of vermicompost reveals that, the per cent N, P_2O_5, K_2O content was 0.8, 1.1 and 0.5 respectively (Giraddi, 1993). The vermicompost not only contains higher nitrate nitrogen at the beginning, but it also has greater nitrifying capacity than the corresponding soil. Nitrogen production from mucus, dead earthworm tissue and vermicasts amounted to 180 kg ha^{-1} $year^{-1}$.

Effect of vermicompost on growth, yield and yield parameters

Vermicompost besides being a rich source of micro and macro nutrients. It also act as chelating agent and regulates the availability of metallic micro nutrients to the plants. It increases the plant growth and yield by providing nutrients in the available form.

Bano and Kale (1987) reported that the application of vermicompost along with chemical fertilizer recorded higher yield of brinjal and radish. Kale *et al.* (1987) reported that, the different concentration of worm cast significantly increased the leaf area index and flowering of salvia and other ornamental plants. In cucumber, application of vermicompost (6.5 t/ha) increased vine length (7.0 cm) and decreased the internodal length (7.4 cm) over control (Haung and Zhao, 1987). Balaji (1994) recorded increased plant height of china aster with the application of vermicompost (2.5 t/ha) in combination with inorganic fertilizer. Nethra (1996) reported maximum plant height with vermicompost along with 50 per cent and 100 per cent recommended NPK in China aster. Jasvir Singh *et al.* (1997) recorded greater plant height and number of branches per plant in chilli with the application of vermicompost @ 10 tonnes per ha.

Sutagundi (2000) reported the higher plant height (99.79 cm) and number of branches (20.28) in chilli at 120 days after transplanting, when applied with vermicompost alone 84.06 cm and 15.17 branches/plant, respectively. Shashidhara (2000) reported that higher plant height (71.2 cm) and number of branches (42.3/hill) with application of vermicompost (2.5 t/ha) + 100 per cent RDF. These were significantly superior over 100 per cent RDF (65.2 cm and 40.2 respectively) alone in chilli. In rice, Sujathamma *et al.* (2001) reported that significantly higher grain yield (3546 kg/ha) and straw yield (5435 kg/ha) were obtained with the application of 50 per cent N through vermicompost plus 50 per cent N through chemical fertilizer compared to control (2978 and 4489 kg/ha respectively) in chilli. Vermicompost being a rich source of micronutrients also acts as chelating agent and regulates the availability of metallic micronutrients to the plants and increases the plant growth and yield by providing nutrients in the available form. Jasvir Singh *et al.* (1987) recorded higher plant height, number of branches and number of fruits per plant in chilli with the application of vermicompost @ 2.0 t/ha. Shashidhara, (2000) observed that field experiment conducted on chilli (cv. Byadagi Kaddi) in Alfisol at ARS, Hanumanamatti with application of 100 per cent RDF together with organics such as FYM (5 t/ha), vermicompost (2.5 t/ha), redgram stalks and biogas slurry (5 t/ha). The treatment redgram stalks and biogas slurry (5 t/ha). Increased the dry fruit yield (639 kg/ha) significantly over 50 per cent and zero per cent RDF (558 and 506 kg/ha, respectively).

Jasvir Singh *et al.* (1997) registered higher fruit yield per plant in chilli with the application of vermicompost @ 10 t per ha, whereas Patil (1993) observed that, inclusion of vermicompost along with 100 per cent RDF + FYM resulted in additional dry chilli yield of 1.68 q per ha.

Patil (1995) reported maximum potato tuber yield due to the application of vermicompost (1 t/ha) + 50 per cent RDF compared to RDF alone. Patil (1998), observed that the applicatio of vermicompost (2.5 t/ha) along with 100 per cent RDF resulted in higher chilli yield of 1.68 q per ha.

Sreenivas *et al.* (2000) recorded significantly higher fruit weight (225.0 g) and fruit yield (2.03 kg/vine) with the application of vermicompost (10 t/ha) along with 50 per cent RDF (50:25:25 kg N, P_2O_5 and K_2O) in ridge gourd. Subbarao and Ravisankar (2001) reported that the application of vermicompost along with NPK (100:60:60 kg/ha) recorded significantly higher fruit length (10.2 cm), number of fruits per plant (14.3) as compared to NPK alone (8.8 cm, 14.0 and 9.64 t/ha, respectively) in brinjal.

Effect of vermicompost on seed yield and quality parameters

Application of vermicompost @ 1 tonne per ha and release of earthworms @ 50,000 per ha increased the pod yield significantly in groundnut (Agasimani *et al.*, 1995). Jeevansab (2000) reported significantly higher number of seeds (188.9) per fruit, seed weight per fruit (1.25 g) and seed weight (0.71 g) with the application of vermicompost + RDF in capsicum.

Shashidhara (2000) reported higher 1000 seed weight (5.69 g) with the application of FYM (5 t/ha) + 50 per cent RDF which was significantly superior over 50 per cent RDF (5.02 g) in chilli.

2.6 NEEM CAKE

Manurial value of neemcake

Oil cakes of different kinds are produced in India to the tune of about two million tonnes annually. They contain not only nitrogen (5.30%) but also phosphorus (1.0%) and potash (1.4%) besides large quantity of organic matter.

Non edible oil cakes like neemcake, castor cake, mahua cake and pongamia cake can be used as manures. These soil application cakes decompose and liberate nitrogen in the form of ammonia for the use of crops readily and gradually like other organic manures and inhibit soil borne pathogens.

Effect of neem cake on growth and yield of capsicum

Rajendran (1993) suggested the use of organic amendments in pest management is considered as an ecologically viable proposition which avoids environmental pollution. He reported that neem cake @ 250 kg per ha with 20 kg N per ha reduced the population of carmine spider mite, leaf hoppers, aphids and whitefly on okra.

Reddy and Padmodaya (1996) reported that application of panchagavya 3 per cent along with neem cake @ 250 g per square meter in tomato recorded maximum shoot length, root length and with highest fruit yield (16.7 tonnes per ha) over control (14.1 t/ha). Singh (1998) conducted an experiment in brinjal, where in basal application of neem cake @ 20 q per ha recorded significantly higher yield of 107.70 q per ha. Further, protection against incidence of borers was also provided by neem cake + neem oils and he concluded that neem products have the potential to increase production without causing environmental problems. Giraddi and Smitha (2002), reported that the application of neem cake, along with in situ incorporation of sunhemp and vermicompost (with reduced inorganic nutrition of 50 per cent) resulted in higher dried chilli yield (3.7 q per ha) which was followed by the standard check that received full package of 100 per cent RDF and plant protection measures with dicofol.

Shashidhara (1999) reported that combined application of organics and inorganics drastically reduced the per cent incidence of murda and leaf curl index (LCI) in chilli. The lowest per cent incidence of murda (1.88%) and LCI (0.4) was noticed in the treatment combination, incorporation of redgram stalk in soil + 100 per cent recommended dose of fertilizer (RDF) followed by biogas spent slurry + 100 per cent RDF (2.66%, 0.52%) compared to 100 per cent RDF alone, thus indicating the influence of organics versus extent of leaf curl.

Effect of neem cake on soil property

Application of organic manures like neem cake, biocompost and vermicompost harboured more microbes in soil than the control. Bacterial, fungal and actinomycetes counts were maximum under organic treatments (Naidu *et al.,* 1999). Sathesh (1998) summarized that FYM when applied along with neem cake enhanced the organic carbon content of the soil.

Desai (1992) reported that the application of one tonne per ha of vermicompost in capsicum resulted in lower yield as compared to chemical treated plot. However, net profit was higher in vermicompost treated plots due to less total input cost.. The quantum of fertilizers could be reduced by 25 to 40 per cent when it was used along with vermicompost as shown in crop response studies in radish, tomato, carrot and brinjal (Kale *et al.*, 1991). Ushakumari *et al.* (1996) recorded 26 per cent increase in yield of bhendi with the application of vermicompost at the rate of 12 t per ha along with full or $3/4^{th}$ of the RDF over application of only RDF.

2.7 BIOFERTILIZERS

Lacatus *et al.* (1995) reported that tomatoes grown in organic media under unheated plastic greenhouses generally had lower acidity, higher sugar and lycopene content compared to the plants grown in soil. They further reported that increasing the peat content reduced the fruit acidity and increased the vitamin -C content in fruits as compared to the crops grown in soil.

Azospirillum brasilense, a heterotrophic nitrogen fixing organism has been reported to be as beneficial and economical on several cereals and in chilli. It improves the growth and yield as well as the productivity of the crop. The use of *Azospirllum* had resulted in increased yields and reduced use of nitrogenous fertilizers in many crops (Dhanapal *et al.*, 1978), Natarajan (1990) reported maximum plant height, number of branches per plant and dry fruit yield (1.83 t/ha) of chilli when FYM was applied at the rate of 25 t per ha as a basal dose along with 75:35:35 kg NPK per ha . Sendurkumaran *et al.* (1998) obtained higher yield (52/ kg plot). TSS (3.9°brix), ascorbic acid (26.9 mg /100 g) and lycopene content (5.81 mg) in tomato with the application of 15 t FYM along with 50 kg of NPK, 250 kg vermicompost and 2 kg each of *Azospirillum* and *Phosphobacteria* per hectare,

Zhao and Lisil (1994) observed that under glasshouse condition of soil inoculated with *Glornus grigarum* and *Glomus* mosseae increased the plant height, number of leaves, stem diameter, dry weight of plant, leaf area and net photosynthetic rate in *Capsicum annuum* var. *grossum.*Whereas, Murumkar and Patil (1996) reported that the interaction of VAM-mixture (*Glomus* sp. + *Gigaspora* + *Acaulospora*) and diazotrophs mixture (*Azotobacter* + *Azospirillum*) resulted in higher bell pepper fruit yield (19.1 t /ha).

Azospirillum and *Azatobacter* inoculants increased the plant height, shoot and root dry weight in tomato (Kumarswamy and Madalageri, 1990) The application of 50 per cent of recommended dose (120:240:120 kg NPK/ha) as basal and another 50 per cent as top dressing along with *Azospirillum* and *Phosphobacteria* resulted in higher tuber yield (25.87 t /ha) and ascorbic acid (21.2mg/100 gm) content in onion (Mahendran *et al.,* 1996).

Gurubatham *et al.* (1989) reported that the bulb yield of onion and TSS content were increased by application of 112.5:112.5 kg N and P per ha along with *Azospirillum*. Pakvarthy and Ramaswamy (1999) obtained higher TSS (16.97°brix), anthocyanin (0.56 mg) and pyruvic acid content (2.23%) in onion with the application of 45 :45:30 NPK kg per ha' along with *Azospirillum* and *phosphobacteria*.

Dhanapal *et al.* (1978) reported that seed inoculated with *Azospirillum* increased the vigour index and seedling growth. Inoculation of *Azospirillum* to seed, soil and seedling increased the number of fruits per plant, fresh and dry weights of pod per plant and ascorbic acid content of bhendi (Balasubramani, 1988) Whereas Karuthamani *et al.* (1995) obtained highest fruit yield (17.79 kg) per plant of pumpkin with combined inoculation of *Azospirillum* + *Phosphobacterium* along with RDF. Both, *Azospirillum* and *Azatobacter* inoculants enhanced the growth, yield and quality attributes of knol-khol as compared to control at all levels of nitrogen (Chatto *et al*., 1997).

2.8 EFFECT OF *AZOSPIRILLUM* GROWTH PARAMETERS

Amirthalingam (1988) observed that soil inoculation of *Azospirillum* along with 50 per cent recommended dose of nitrogen increased the plant height and number of branches in chilli. Plant height, shoot growth and fruit yield of bhendi were significantly improved due to application of *Azospirillum inoculum* at rate of 2.5 kg per ha (Paruatham *et al.*, 1989). Paramaguru and Natarajan (1993) noticed significant difference in growth parameters in chilli. The application of *Azospirillum* (10 kg/ha) with nitrogen (56 kg/ha) showed significant increase in the plant height (56.13 cm) and number of lateral branches (6.3) compared to control (48.21 cm and 5.4). Deka *et al.* (1996) reported that application of *Azospirillum* to chilli plants along with 70 kg N per ha produced the higher plant height (101.1 cm) and branches (11.2/plant) as compared to 70 kg N per ha (92.2 cm and 8.3 respectively) when applied singly.

Balasubramanian *et al.* (1997) reported that soil treatments of *Azospirillum* (2 kg/ha) with 30 kg nitrogen per ha took less number of days (32.6) for first flowering compared to 30 kg N per ha alone (35.5) in bhendi. Sendurakumaran *et al.* (1998) reported less number of days (56.31) with application of *Azospirillum* (2 kg/ha) + phosphobacteria (2 kg/ha) + NPK (150:100:50 kg/ha) compared NPK alone (62.01) in tomato. Nirmala *et al.* (1999) reported less number of days for appearance of first female flower (47.9) and narrower sex ratio (6.80) with application of *Azospirillum* (2 kg/ha) + *Phosphobacteria* compared to control (67.8 and 8.20 respectively) in cucumber.

Jeevansab (2000) reported that *Azospirillum* + RDF (150:75:50) took more number of days (37.81) to 50 per cent flowering as compared to RDF (36.6) alone in capsicum. Govindarajan and Thangaraju (2001) reported that dual inoculation of *Azospirillum* with phosphate solubilising bacteria resulted in additional benefit by increasing the plant height in chilli.

Renuka and Ravisankar (2001) noticed lower plant height (92.23 cm) and branches per plant (2.33) when *Azospirillum* and *Phosphobacteria* were applied compared to NPK alone (110.41 cm and 3.66 respectively) in tomato.

Effect of *Azospirillum* on fruit yield and yield parameters

Parutham and Vijayan (1989) reported that the highest yield of bhendi 15.6 t per ha was noticed with soil application of *Azospirillum*. Bhendi fruit yield and N use efficiency were highest in plots receiving N at 50 per cent of the recommended dose along with soil applied *Azospirillum* (Subbaiah, 1991). Paramaguru and Natarajan (1993) reported that application of nitrogen (56 kg/ha) with *Azospirillum* (10 kg/ha) showed significant increase in the fruit yield (2.45 t/ha) as compared to control (1.07 t/ha). Karuthamani *et al.* (1995) obtained highest fruit yield per plant (17.79 kg) of pumpkin with combined inoculation of *Azospirillum* + phosphobacteria along with RDF.

Application of 50 per cent RDF (120:240:120 kg NPK/ha) along with *Azospirillum* + phosphobacteria resulted in higher tuber yield (25.87 t/ha) in onion (Mahendran *et al.*, 1996). Duraisamy *et al.* (1999) reported higher fruit yield (9.40 t/ha) with *Azospirillum* application as compared to control (8.66 t/ha) in tomato. Jeevansab (2000) noticed that *Azospirillum* + RDF reported significantly higher number of fruits (9.32), fruit length (7.8 cm) and girth (6.3 cm) and fruit yield (868.5 g/plant) compared to 50 per cent RDF (8.5, 7.3, 5.3 cm and 690.2 g respectively) in capsicum.

Shashidhara (2000) noticed significantly higher fruit length (11.7 cm), lower fruit number (8.9) and fruit yield (400.1 kg/ha) with application of *Azospirillum* (0.5 kg) + phosphobacteria (0.5 kg/ha) compared to 50 per cent RDF (10.2 cm, 12.6 and 500.6 kg/ha) alone in chilli.

Effect of *Azospirillum* on seed yield and quality parameters

Dhanapal *et al.* (1978) reported that, inoculation of *Azospirillum* increased the vigour index and seedling growth in pearl millet. Amirthalingam (1988) observed that, soil inoculation of *Azospirillum* along with 50 per cent of recommended dose of nitrogen increased the seedling length and vigour index in chilli. Inoculation of *Azospirillum* (2 kg/ha) to soil increased the number of seeds per fruit, seedling length, vigour index and seedling dry weight in bhendi (Balasubramani, 1988). *Azospirillum* inoculation significantly increased the growth, yield, nutrient uptake, dry matter and vitamin C content in chilli (Balakrishnan, 1988).

Ramachandran and Prasad (1995) noticed *Azospirillum* inoculation significantly increased the sesamum seed yield (4.21 q) over inorganic fertilizers (3.42 q). Mahendran and Kumar (1996) observed increased bulb yield of garlic was about 15.04 per cent with application of *Azospirillum*. Balasubramani *et al.* (1997) stated that significantly higher germination (97.2%) was recorded when *Azospirillum* (2 kg/ha) was applied along with nitrogen (40 kg/ha) compared to nitrogen alone (87.9%) in okra. Chattoo *et al.* (1997) reported that inoculation of both *Azospirillum* and Azatobacter enhanced the growth, yield and quality attributes of Khnol-khol as compared to control at all levels of nitrogen. Jain *et al.* (1999) reported significantly higher seed yield (15.4 g/plant), seed weight (15.0 g) and seed

yield (9.7 q/ha) with application of P-solubilizers in combination with 60 kg P_2O_5 over control (13.8 g, 10.9 g and 7.4 q, respectively) in chickpea. Prabakaran *et al.* (1999) reported that the inoculation of *Phosphobacteria* along with *Azospirillum* improved the seed yield (735 kg/ha) over control (550 kg/ha) in horsegram. Bhagchand and Gautham (2000) reported that significantly lower seed weight (8.1 g) was recorded with the application of *Azospirillum* (2 kg/ha) compared to 10 t FYM per ha (8.2 g) and 40 kg N + 20 kg P_2O_5 per ha (8.24 g) in pearl millet. Whereas, Jeevansab (2000) recorded significantly higher number of seeds per fruit (194.8), seed weight per fruit (1.44 g) and 100 seed weight (0.75 g) with the application of *Azospirillum* + RDF as compared to 50 per cent RDF (175.8, 1.32 g and 0.72 g, respectively) in capsicum.

Shashidhara (2000) noticed that, application of *Azospirillum* + *Phosphobacteria* recorded higher 1000 seed weight (5.93 g) which was significantly superior over 50 per cent RDF (5.40 g) in chilli.

2.9 EFFECT OF NAA ON GROWTH PARAMETERS

Chattopadhyay and Sen (1974) reported that spraying of 70 ppm NAA at pre-bloom stage not only increased short styled flowers of chilli but also increased the per cent fruit set (51.92%) compared to water spray (32.92%). Mote *et al.* (1975) reported that spraying of 50 ppm NAA at full bloom stage and 20 days after full bloom recorded lower flower drop in chilli. Pandita *et al.* (1980) reported that spraying of 10 ppm. NAA at flowering stage and three weeks later produced significantly more plant height (62.12 cm) over water spray (49.46 cm) in chilli.

Arora *et al.* (1982) noticed that number of days to initiation of first male (46.2) and female (49.3) flowers were reduced by NAA (50 ppm) spray compared to control (49.3 and 52.4 respectively) in bottle gourd. Sharma *et al.* (1988) reported that number of days for appearance of first staminate and pistillate flower and sex ratio (M:F) were significantly affected by foliar spray of NAA. The earliest appearance of first staminate (46 days) and pistilate flower (49 days) were observed by NAA 50 ppm and it also recorded narrow sex ratio (4.0) as compared to control in bottle gourd.

Yamger and Desai (1987) observed that, spraying of NAA (10 ppm) at 20 days after transplanting produced higher per cent of short styled flowers and fruit set (61.7%) over unsprayed plants (47.55%) in chilli cv. Pusa Jwala. Maurya and Lal (1987) witnessed that, chilli plants sprayed with NAA (150 ppm) at flowering and 15 days interval for three times recorded the highest plant height (63.05 cm) while the lower plant height (49.16 cm) was observed in water spray. Usharani and Peter (1988) reported that 15 ppm NAA sprayed at 15, 30, 45 and 60 days after transplanting reduced the flower drop (15.17%) compared to water spray (65.17%) in chilli. cv. Pusa Jwala, Dod *et al.* (1989) recorded increased plant height by spraying of NAA 50 or 100 ppm at full bloom stage (50 DAT) and again at an interval of 21 days compared to no spray (control). Singh *et al.* (1990) stated that spraying of NAA at 10 ppm at 40 and 60 days after transplanting recorded higher number of branches per plant (10.0) against water spray (8.9) in chilli.

Lata and Singh (1993) sprayed NAA (20, 40 and 60 ppm) at 30 and 60 days after transplanting and observed that the fruit set was higher (42.75%) with 40 ppm NAA and beyond this concentration; the fruit set percentage reduced greatly in chilli. The application of NAA (10 and 20 ppm) at 40 and 60 days after transplanting recorded 7.27 and 6.80 primary 16.84 and 16.47 secondary and 53.38 and 53.69 tertiary branches respectively compared to water spray 4.39, 1.87 and 44.67 primary, secondary and tertiary branches per plant respectively in chilli. Increase in number of branches were due to the stimulating action of auxins which soften the cell wall of the stem and increase its plasticity (Revanappa, 1993). Patel and Saxena (1994) indicated the seed treatment of black gram and greengram with NAA (10^{-6} m) significantly increased the shoot and root length and also leaf number per plant.

Baruah and Das (1997) reported significantly higher vine length, internodal length (14.6 cm) and lower number of branches (12.0) with NAA 100 ppm over control in bottle gourd. Similarly, Ingle *et al.* (2000) reported that spraying of NAA had significant effect on vine length and number of branches per vine. Significantly higher vine length (424.4 cm) and

number of branches (10.44) were recorded with NAA 100 ppm and 200 ppm respectively in bottle gourd.

Baruah and Das (1997) recorded minimum number of days for appearance of first male (59.7) and female flower (80.5) and narrow male to female ratio (7.1) in NAA 100 ppm compared to control in bottle gourd. Gedam *et al.* (1998) observed higher number of female flower (34.4) and lowest sex ratio (5.2) with NAA 50 ppm in bitter gourd. Gupta *et.al*. (1997) observed an increase in the plant height (112 to 122 cm) with increase in the GA_3 concentration from 100 to 300 ppm as compared to control (106 cm) in brinjal. Shukla *et al.* (1997) obtained increased plant height (52.7 cm), number of branches (4.93), pods (57.2), pod weight (16.7 g) and seed yield (1686.6 g) per plant over control by spraying NAA (4 ml/l) in soybean.

Rafeeker *et al.* (2002) visualized that, NAA 100 ppm was less effective in inducing number of branches and it increased the internodal length in cucumber.Kore *et al.* (2003) recorded significantly higher vine length (303.6 cm) internodal length (10.03 cm) and number of branches (4.13) with NAA (20 ppm) compared to control in bottle gourd.

Effect of NAA on fruit yield and yield parameters

Chattopadhyay and Sen (1974) sprayed 50 and 75 ppm NAA at pre-bloom stage and observed the higher fruit length (4.00 cm) by application of 50 ppm NAA. Beyond this dosage, the fruit length was adversely affected in chilli cv. Suryamukhi.

Mangal *et al.* (1981) recorded higher number of fruits (20.4) and fruit yield (2061 g/vine) with foliar spray of NAA (50 ppm) compared to control (17.3 and 13.56 g respectively) in bitter gourd. Bangal *et al* .(1982) reported that, foliar spray of NAA (25 and 50 ppm) showed maximum grain weight per plant (11.33) and (10.19 g) pod number per plant (63.44 and 64.33 g), grain number per plant (1.15 and 1.09), 100 grain weight (14.40 and 14.28 g) as compared to control.

Patil *et al.* (1985) reported that, fruit length of chilli was significantly increased by the application of NAA (20 and 30 ppm) at first flower opening followed by two sprays at an interval of 30 days.

In bottle gourd, number of fruits and fruit yield per vine and fruit yield per ha were significantly enhanced by NAA treatments. NAA (50 ppm) showed significant increase in number of fruits per vine (7.8), fruit yield (5.28 kg/vine and 3168 q/ha) over control (Sharma *et al.*, 1988). Hulamani (1988) obtained significantly increased mean fruit length (9.07 cm) of chilli by spraying of NAA 20 ppm at 40 and 60 days after transplanting as against water spray (8.21 cm). Increased fruit size due to NAA application was ascribed to its involvement in high rate of cell-division and cell-elongation or both and also due to translocation of metabolities from source to sink.

Doddamani and Panchal (1989) recorded that foliar spray of NAA 10 ppm at pre-bloom stage recorded significantly increase in fruit thickness at first, second and third pickings (12.90, 13.00 and 13.10 mm) compared to control (7.80, 8.00 and 7.90 mm) in chilli. Mandal *et al.* (1990) noticed longest (58.3 cm) and thicker (37.89 cm) fruit with spray of NAA (100 ppm) compared to control (42.5 cm and 30.1 cm, respectively) in bottle gourd. Singh *et al.* (1990) reported that fruit length of chilli was significantly higher (11.51 cm) with 40 ppm NAA as compared to water spray (9.37 cm).Lata and Singh (1993) reported that foliar spray of NAA (20-60 ppm) at 30 and 60 days after transplanting recorded higher number of fruits per plant (155) as compared to the water spray (120) in chilli.

Revanappa (1993) noticed that foliar spray of NAA at 10 and 40 ppm recorded fruit girth of 1.43 and 1.49 cm respectively as compared to the water spray (12.6 cm). Singh and Lal (1995) recorded significantly higher (421.00 g) seed yield per plant by the application of 40 ppm NAA against untreated plants (37.40 g) in chilli. Gedam *et al.* (1998) observed maximum number of fruits (11.57/vine), fruit yield (1.42 kg/vine and 11863 kg/ha) by spraying NAA (50 ppm) and were significantly superior over control. NAA 50 ppm also recorded less number of days to fruit maturity (19.3) compared to control in bitter gourd.

Balaraj (1999) recorded increased plant height (92.62 cm) with NAA 20 ppm sprayed at 35 and 50 days after transplanting as compared to control (93.97 cm). Gollagi (1999) observed increased number of seeds per fruit (85.2) with application of 100 ppm NAA at 45 and 65 days after transplanting against unsprayed plants (63.3). Gutam (1999) noticed higher fruit yield per ha (3147 kg) with NAA 50 ppm over control (2986 kg) in bell pepper.

Goudappalavar (2000) reported significantly higher plant height (115.7 cm) with NAA (100 ppm) sprayed at 50 per cent flowering stage as compared to control (70.6 cm) in tomato.

Effect of NAA on seed yield and quality parameters

Singh and Lal (1995) sprayed NAA (10 to 80 ppm) at 40 and 60 days after transplanting and reported that higher (66.1%) seed germination in chilli was recorded with 20 ppm NAA compared to water spray (56.1%). Gedam *et al.* (1996) recorded significantly higher number of seeds (27.41/fruit), 100 seed weight (21.42 g), germination (68.00%) and vigour index (2111) with foliar spray of NAA 100 ppm as compared to control (26.25, 30.12 g, 63.0 and 1975 respectively) in bitter gourd. Gedam *et al.* (1998) stated that the number of seeds per fruit (340) and seed yield per ha (789.3 kg) increased significantly due to spraying of NAA 50 ppm compared to control (184 and 459.4 kg respectively) in bitter gourd.

Balaraj (1999) observed with foliar spray of NAA 20 ppm at 35 and 50 days after transplanting resulted in significantly higher number of seeds (49.43) per fruit, seed yield per ha (684 kg) and 1000 seed weight (5.97 g) over control (41.34, 443 kg and 5.10 g, respectively). However, plants sprayed with 20 ppm recorded highest germination (93.49%), seedling length (19.87 cm) and vigour index (1857) as compared to control (86.143%, 17.34 cm and 1494, respectively).

Tiwari *et al.* (2001) noted significant improvement in per cent germination (90.7) and seedling length (6.63 cm) with foliar spray of NAA 50 ppm over control (82.0 and 58.3 cm, respectively) in onion. Yoganand (2001) reported that, higher germination (67.64%) root length (5.01 cm) and shoot length (6.75 cm) were obtained in bell pepper when sprayed with 40 ppm NAA as against control (64.91%, 4.25 cm and 5.22 cm, respectively).

3. MATERIAL AND METHODS

A field experiment was conducted to study the effect of organic manures involving farmyard manure vermicompost, neemcake, biofertilizers on growth, seed yield and quality of *Capsicum annuum*. The experiment was laid out during summer 2007-08 under irrigated condition, in medium black soil at Agricultural Research Station, Bagalkot, University of Agricultural Sciences, Dharwad. The seed quality studies were carried out in the PG laboratory of Seed Science and Technology Department, UAS, Dharwad. The details of the materials used and experimental techniques adopted during the course of investigation are described in this chapter.

3.1 GENERAL DESCRIPTION

3.1.1 Location of the experimental site

The experiment was conducted at Agricultural Research Station, Bagalkot, University of Agricultural Sciences, Dharwad in plot number 6. Bagalkot is situated between 16˚ N Latitude , 76˚ C Longitude and at an altitude of 531.0 m above the mean sea level.

3.2 SOIL PROPERTIES OF EXPERIMENTAL SITE

The soil of the experimental site at Agricultural Research Station, Bagalkot are deep black in nature. The composite soil sample from the experimental site was drawn before commencement of the experiment and analyzed for the different physical and chemical properties by following the standard procedure. The results are given in Table 1.

3.3 CLIMATIC CONDITIONS

The Agriculture Research Station is situated in Northern dry zone (Zone-3) of the karnataka state. The zone receives rainfall from both southwest and northeast monsoons. Well distributed rainfall from June to November with lower co-efficient of variation. The mean monthly meteorological data of rainfall, temperature and relative humidity during the period of experiment and average for fast 10 years are presented in Table 1. During the year July 2007 to June 2008, the total rainfall of 825mm was received. September and October received higher rainfall than the normal. Maximum temperature ranged from 37.5˚C, while mean monthly minimum temperature ranged was 15.4˚C.

3.4 VARIETAL DESCRIPTION OF *Capsicum annuum* CV.CALIFORNIA WONDER

California wonder plants are tender perennial grown in temperate regions as annual. Flowering either solitary or in two or three flower clusters,flower is greenish white anther is not fused in a tight cone. The fruit is berry with large locules, four lobed, smooth, heavy thick deep glossy scarlet. Flesh is thick, sweet and fine flavoured. Immature colour green turning red (some gold or yellow) at maturity. It takes 130 to 145 days for maturity.

3.4.1 Experimental details

The experiment was conducted during summer 2007-08.

Experiment: Studies on organic seed production in Capsicum

The experiment consisted of 16 treatment combinations with 4 soil application of organic manures as one factor and 4 foliar sprays as another factor. The details of the treatment are given below

Treatment details

The experiment consisted of 16 treatment combinations.

Table 1. Physical and chemical properties of soil of the experimental site

Sl. No.	Particulars	Values (0-30 cm depth)	Method employed
I.	Physical properties		
1.	Coarse sand (%)	7.64	International Pipette method (Piper, 1966)
2.	Fine sand (%)	11.50	
3.	Silt (%)	17.30	
4.	Clay (%)	61.50	
II.	Chemical properties		
1.	pH	6.70	Buckmoric pH meter (Piper, 1966)
2.	Electrical conductivity (dS/m)	0.29	Jackson (1973)
3.	Organic carbon (%)	0.50	Wet oxidation method (Jackson, 1967)
4.	Available nutrient status		
	a) Available N (kg/ha)	218	Alkaline permanganate method (Subbaiah and Asija, 1956)
	b) Available P (kg/ha)	26.5	Olsen's method (Jackson, 1967)
	c) Available K (kg/ha)	378.6	Flame photometer method (Tandon, 1993)

Table 2. Meteorological data from last 10 years and during period of experiment at Agricultural Research Station, Bagalkot

Month	Rainfall (mm)		Mean Temperature (℃)				Relative humidity (%)	
			Maximum		Minimum			
	1998-2007	2007-08	1998-2007	2007-08	1998-2007	2007-08	1998-2007	2007-08
July	48	46.6	29.8	29.8	21.9	27	79	73
August	68.4	144.2	29	27.6	21.5	26.4	79	80
September	89.2	246.5	29.8	26.9	21.1	26.3	78	85
October	139	30.2	29.4	29.5	20.7	25	75	76
November	4.82	4	29	28.6	17.4	15.9	69	65
December	0	0	27	28.3	13.3	15.3	69	66
January	1.11	0	27.1	28	14	13.5	68	63
February	1.62	56.4	31.1	30.3	16.7	16.6	62	64
March	3.34	153.4	35.4	31.6	19	18.8	59	69
April	17.8	2	37.1	29.8	22.4	19.1	60	53
May	53.7	84	36.8	34.5	23	20.1	65	51
June	72.2	57.8	31.4	34.8	22.4	21.3	75	64
Total	499	825.1	31.07	29.97	19.45	20.44	69.8	67.4

Treatment details are as follows

Factor I:

Soil application (S)

S_1: RDF + FYM (25t/ha)

S_2 : FYM (50%) + Vermicompost (50%)

S_3 : FYM (50%) + Vermicompost (50%) + neemcake (500 kg/ha)

S_4 : FYM (50%) + Vermicompost (50%) + Biofertilizer (5 kg/ha *Azospirillum* + PSB)

Factor II :

Foliar application (F)

F_1 : Panchagavya (5%)

F_2 : Vermiwash (5%)

F_3 : NAA (10 ppm)

F_4 : Control (Water spray)

RDF :100 :50 :50 kg NPK per ha.

FYM : 25 tonnes per ha.

FYM (50 %) :12.5 tonnes per ha.

Vermicompost (50 %) :2.5 tonnes per ha.

Replication : Three

Plot size

Gross plot: 3.0 m x 3.0 m = 9 Sq.m

Net plot: 2.60 m x 2.60 m = 6.76 Sqm.

Spacing: 60 cm x 60 cm

Design :RBD in factorial concept

Treatment combinations

S_1F_1	S_2F_1	S_3F_1	S_4F_1
S_1F_2	S_2F_2	S_3F_2	S_4F_2
S_1F_3	S_2F_3	S_3F_3	S_4F_3
S_1F_4	S_2F_4	S_3F_4	S_4F_4

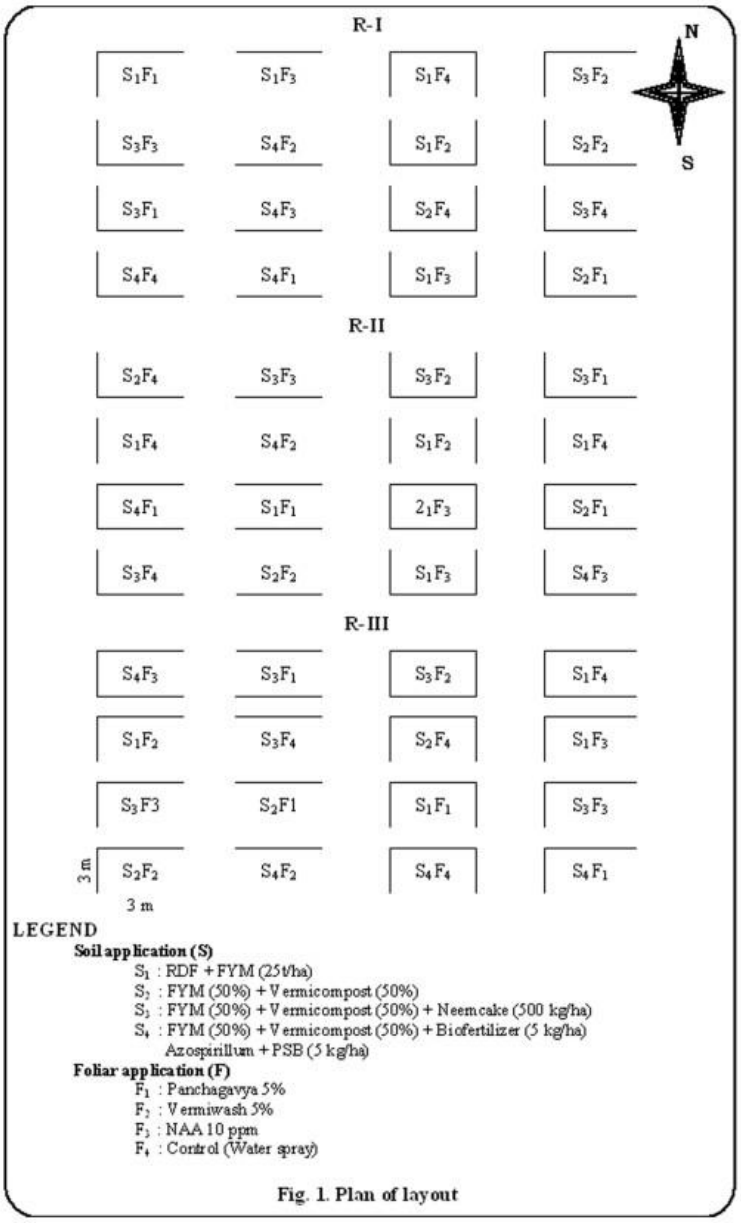

Fig. 1. Plan of layout

Fig 1. Plan of layout

Plate 1. General view of experimental plot at 90 DAT

Plate 2. FYM 50 per cent + vermivromost 50 per cent + biofertilizer

Panchagavya preparation

Ingredients:		
	Cowdung	: 7 kg
	Cow urine	: 3 litres
	Cow's milk	: 2 litres
	Cow's curd	: 3 litres
	Cow's clarified ghee	: 1 kg
	Yeast	: 100 g
	Tender coconut water	: 3 litres
	Ripened banana	: 12 number

The fresh cow dung and ghee were mixed together and kept in a plastic bucket for two days. This mixture was stirred once in a day. On third day, added three litre of cow urine, ten litre of water and allowed to ferment for 12 days and then added two litre of curd, two litre of milk, 100 g. of yeast, two litre of coconut water, three litre of sugar cane juice or 250 g jaggery and 12 ripe bananas and again allowed to ferment it for another 15 days. The container was covered with wire mesh and kept under shade for fermentation and stirred thoroughly thrice a day. The panchagaya is ready within 27 days . It was used at the rate of 5 per cent as a foliar spray.

3.4.2 Preparation of Vermiwash

Materials required

The method of preparing easy and low cost vermiwash requires the following materials.

1. Plastic or brick made barrel of 100 litres capacity
2. Plastic piper tap (1/2 inch)
3. Vermiwash collecting bin/jar/pot
4. Well decomposed organic matter
5. Brick pieces and sand
6. Cowdung
7. Plastic bucket/cement pan (innerpon)
8. Earthworms

Procedure

Place 10 litre bucket inverted in a 100 llitre capacity cement or plastic barrel fill the outer barrel with brick pieces and sand until the small bucket is immersed. There broken pieces and sand help to filter the vermiwash keep the plastic pipe such a way that it come from smaller bucket to outside the bigger one. So as to collect vermiwash from smaller bucket. Then join a tap to the pipe, now fill the bigger barrel with well decomposed material. Then leave 4-5 kg earthworms for every 100 kg of organic matter in the basket. Spray water after leaving earthworms in the barrel. Put 4-5 l of water, 100-150 g. of cow dung daily to the barrel. The added water possess through the organic matter and washes the body of earthworms and comes through bricks and sand by filteration after it collects in the inverted bucket through pipe this water we called as vermiwash. This has to be preserved in the earthern pot and by this we can get 4-5 l/day of vermiwash.

3.4.3 Design and layout

The experiment was laid out in factorial Randomized Block design with factorial concept in three replications

Table 3. Details of score used to determine for leaf curl index (LCI)

Number	Score	Symptoms
1	0	No symptom
2	1	1 to 25 per cent leaves per plant show curling
3	2	25 to 50 per cent leaves per plant show curling Moderately damage
4	3	51 to 75 per cent per plant show curling Heavily damaged Malformation of growing points Reduction in plant height
5	4	75 per cent leaves per plant show curling Severe complete distraction of growing points Drastic reduction in plant height De-foliation and sever malformation

Leaf curl index (LCI) was calculated by multiplying the score by number of plants in that category and dividing the sum of the product by total number of plants scored.

$$LCI = \frac{0 \times a + 1 \times b + 2 \times c + 3 \times d + 4 \times e}{a + b + c + d + e}$$

Where, a, b, c, d and e indicate number of plants

Niles (1980)

3.5 CULTURAL PRACTICES

Land Preparation

The land was ploughed once with mould board plough followed by two harrowing to bring the soil to fine tilth. The plots were laid out as per the plan before transplanting.

Nursery

The soil was brought to fine tilth and raised seed bed of 15 cm height were prepared and well rotten farmyard manure and vermicompost were incorporated into soil .Seeds were treated with Trichoderma viridae @ 5 g per kg of seeds .Then seeds were sown on 15 th of February 2008 in rows of 10 cm apart and covered with a layer of soil .The nursery beds were mulched with straw and watered twice in a day.The mulch was removed just after seed were germinated.

Transplanting

The field was marked with a spacing of 60 cm x 60 cm using marker. The 30 days old two healthy seedlings were transplanted per hill in the main field.

Fertilizer application

The organics were applied and mixed with the soil well before transplanting. The recommended dose of fertilizer was applied in inorganic treatment at the rate of 100:50:50 kg N: P:K/ha. While in case of organics worked out on the basis of equivalent nitrogen.

Nutrient composition of different organic manures were given below

Nutrient composition of organics (%)

Sl.No.	Particulars	N	P	K
1	FYM	0.50	0.2	0.5
2	Vermicompost	2.01	1.1	0.5
3	Neem cake	5.03	1.0	1.4

Irrigation

The protective irrigation were given once in 8-10 days during the crop growth period depending upon soil and climatic condition.

Seed source

The seeds of California wonder were procured from the professor and head Department of horticulture, UAS, Dharwad.

Cultural operations

The details of cultural operations carried out during the course of investigations are as follows.

Gap filling

Gap filling was done eight days after transplanting with seedlings of same age to ensure optimum plant population.

Weeding and intercultivation

Intercultivation was carried out 20, 40 and 60 days after transplanting followed by two hand weedings at 30 and 60 days after transplanting to keep the experimental plot weed free.

Plant protection measures

The schedule of different plant protection measures were taken against pests and diseases during the period of investigation were as follows. The crop was regularly sprayed with neem oil 5ml/lit at 30, 60, 90 days after transplanting to control thrips and mites and leaf eating caterpillar. The Ecohume (1ml/lit) and Biozyme (1ml/lit) was sprayed to control flower drop and fruit set.

Picking, harvesting and drying

The ripened fruits were picked at a interval of one to two weeks and harvesting continued over a period of about one month. The numbers of pickings were three. The riped capsicum was dried in sunshine for one week. The seeds were separated manually and dried under shade.(plate 1and 2).

3.6 COLLECTION OF EXPERIMENTAL DATA

For analyzing the growth pattern of the crop, five plants were selected randomly from the net plot area in each treatment and recorded various observations at 45, 90 days after transplanting and at harvest. The parameters and procedures followed are given below.

3.6.1 Growth parameters

Plant height (cm)

The plant height of the five tagged plants were recorded in centimeter and measured at 45 and 90 DAT at harvest from the base of the plant to the tip of the growing plant and the average height was worked out.

Number of branches per plant

Total number of branches per plant were recorded from randomly selected five tagged plants at 45 and 90 DAT and at harvest and the average number of branches per plant was worked out.

Number of leaves per plant

Total number of leaves per plant were counted from randomly selected five tagged plants at 45 and 90 DAT and at harvest and mean was worked out and expressed as number of leaves per plant .

Days to flower initiation

The number of days required to first flowering in the selected plants in each treatment was recorded and expressed as days to initiation of flowering.

Days to 50 per cent flowering

The daily observation was made on five randomly selected and tagged plants for flowering. The day on which 50 per cent of plants showed flower anthesis was considered as days to 50 per cent flowering. .

3.6.2 Yield and yield attributes

Number of fruits per plant

The ripened red coloured fruits harvested from five randomly tagged plants in each treatment were counted from different pickings and average was worked out and expressed as number of fruits per plant.

Fruit yield per plant (g)

The total number of fruits in plant are picked and weighed and observations are obtained average was worked out and expressed in grams per plant.

Fruit yield per plot (kg)

The fruits harvested from the net plot area were dried under partial shade before recording fruit weight, fruit yield per plot was computed and expressed in kg per plot.

Fruit yield per hectare

The fruits harvested from the net plot were dried before recording fruit weight. The fruit yield per hectare was computed and expressed in Kg per hectare..

Number of Seeds per fruit

The seeds were removed from five randomly selected fruits from five plants in each treatment. The number of seeds per fruit was counted and average was worked out and was expressed as number of seeds per fruit.

Seed weight per plant (g)

The weight of seeds from five plants selected at random from the plot was recorded and the average seed weight per plant was obtained.

Seed yield per hectare (kg/ha)

Seed yield per hectare was computed based on seed yield per plot and expressed in kg per hectare.

3.6.3 Quality parameters

Seed germination (%)

The germination test was conducted as per the ISTA procedure (Anon., 1999), using between paper method. One hundred seeds were equally placed on the germination paper in four replications and these rolled paper towels were placed in a slanting position in the seed germinator maintained at the constant temperature of 25 ± 1°C and 95 ± 1 per cent relative humidity. The number of normal seedlings was counted at the end of 14 th day and was expressed as germination percentage.

Root length (cm)

Ten normal seedlings in each treatment were randomly chosen for measurement of root on the day of final count and the average was calculated. The length of the root was also measured in cm from collar region to the tip of the main root.

Shoot length (cm)

Ten normal seedlings in each treatment were randomly chosen for measurement of shoot on the day of final count and the average was calculated. The shoot length was measured from the collar region to the point of attachment of cotyledon and expressed in centimeters.

Seedling vigour index (SVI)

The seedling vigour index was calculated by adopting the formula as suggested by Abdul Baki and Anderson (1973) as described below. The average SVI was calculated and expressed in pure number.

SVI = (Root length + Shoot length in cm) x Germination percentage.

Seedling dry weight (mg/Seedling)

Ten normal seedlings used for measuring shoot length were kept in butter paper bag and dried in hot air oven at 103 ± 1˚ C at a constant temperature for 16 ± 1 hour. Then the seedlings were weighed after allowing them to cool at ambient temperature in a desicator and expressed in milligrams.

Electric conductivity (dS/m)

Five grams of seed were surface sterilized by using 0.1% $HgCl_2$ solution for five minutes, then washed in distilled water for five minutes. These seeds were soaked in 25 ml of distilled water for 24 h. at room temperature. After soaking the solution was decanted and volume was made up to 25ml by adding distilled water. Electrical conductivity of the seed leachate was measured through the Electrical conductivity bridge and expressed in dsm^{-1}.

Drying

Manually cleaned seed was again dried in the shade to reduce the moisture to 8 per cent and seed yield was recorded.

Economic analysis

The net return per hectare was worked out for all the treatments by subtracting the cost of cultivation from the gross returns. The return per rupee invested (B:C ratio) was also calculated as follows.

$$\text{B:C ratio} = \frac{\text{Gross returns}}{\text{Total cost of cultivation}}$$

3.7 ECONOMICS

Additional cost involved and returns obtained with different organic manures and chemical fertilizers was worked out on the basis of market rate of all the applied inputs during experimentation as per hectare basis (Appendix II).

3.8 STATISTICAL ANALYSIS

The data collected in respect of various parameters on growth, fruit yield and seed yield and other attributes were analysed statistically as described by Sundarraj and Muthuswami (1972) and Panse and Sukhatme (1978). The critical difference (CD) values were calculated at 5 per cent probability level whenever ‘F’ test was significant.

4. EXPERIMENTAL RESULTS

The results of the investigation entitled “Effects of soil application and foliar spray of organics on growth, seed yield and quality of *Capsicum annuum* was carried out at Agricultural Research Station, Bagalkot and Laboratory studies at Seed Science and Technology, Agriculture College, Dharwad during the summer 2007-2008 are presented here under.

4.1 GROWTH PARAMETERS

Plant height (cm)

The data on plant height at 45, 90 days after transplanting and at harvest as influenced by soil application and foliar spray of organics and their interactions are presented in Table 4.

The plant height differs significantly due to soil application of organics at 45, 90 DAT and at harvest. The soil application of FYM 50 per cent + vermicompost 50 per cent + biofertilizer (S_4) recorded significantly higher plant height at all the stages of 45, 90 and at harvest (21.85, 35.19 and 42.95 cm) respectively over S_1 (RDF + FYM (25 t/ha). However, S_2 and S_3 were on par with each other except at harvest.

Foliar application significantly influenced the plant height at 45, 90 DAT and at harvest. The foliar application of NAA at the rate of 10 ppm recorded significantly higher plant height (21.34 cm, 36.02 and 42.44 cm) at 45, 90 DAT and at harvest respectively over (F_4) control.

The interactions due to soil application and foliar spray had no significance at all the stages of crop growth. However, the higher plant height was recorded with S_4F_3 except at 45 days after transplanting.

Number of leaves per plant

The data on number of leaves at 45, 90 DAT and at harvest as influenced by soil application and foliar spray of organics and their inter actions are presented in the Table 5.

The number of leaves differed significantly due to soil application of organics at 45, 90 DAT and at harvest. Among the soil application of FYM 50 per cent + vemricompost 50 per cent + biofertilizer recorded significantly more number of leaves per plant (30.80, 64.66 and 73.43 per plant) at 45, 90 DAT at harvest respectively over S_1 (RDF + FYM (25 t/ha)). However, S_2 and S_3 are on par each other except at harvest.

Similarly the number of leaves varied significantly 90 DAT and at harvest except at 45 DAT due to foliar application of NAA @ 10 ppm recorded more number of leaves (30.83, 62.10 and 70.43) at 90 DAT and at harvest respectively over control (F_3).

The interaction of soil and foliar application did not differ at all the stages of crop growth. However, numerically more number of leaves was seen with S_4F_3.

Number of branches per plant

The data on number of branches at 45, 90 DAT and at harvest as influenced by soil application and foliar spray of organics and their interactions are presented in this Table 6.

Number of branches differs significantly due to soil application of organics. Soil application of FYM 50 per cent + vermicompost 50 per cent + biofertilizer to soil recorded significantly more number of branches (5.37, 13.12 and 14.22) respectively over S_1 (RDF + FYM). However, S_2 (FYM 50% + vermicompost 50%) and S_3 (FYM 50% + vermicompost 50% + neem cake 500 kg/ha) are on par each other.

Table 4. Effect of soil application and foliar spray of organics on plant height (cm) at different stages of crop growth

Treatments	45 DAT					90 DAT					Harvest				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
S_1	17.46	19.87	22.12	17.19	19.16	29.52	31.65	34.22	32.95	32.09	40.42	38.81	38.77	35.93	38.48
S_2	19.97	21.22	20.57	16.87	19.66	34.85	32.39	34.36	31.01	33.15	38.41	39.12	42.22	35.82	38.89
S_3	20.00	20.21	20.79	18.26	19.82	33.93	35.22	35.85	33.48	34.62	42.68	42.09	42.03	41.00	41.95
S_4	19.60	21.99	21.87	23.97	21.85	34.39	36.41	39.64	30.31	35.19	40.45	43.12	46.72	41.53	42.95
Mean	19.26	20.82	21.34	19.07	20.12	33.17	33.92	36.02	31.94	33.76	40.49	40.79	42.44	38.57	40.57
For comparing means of	S.Em±		CD at 5%			S.Em±		CD at 5%			S.Em±		CD at 5%		
S	0.56		1.63			0.80		2.32			0.91		2.64		
F	0.56		1.63			0.80		2.32			0.91		2.64		
SxF	1.13		3.26			1.60		4.63			1.82		5.27		

Soil application (S)
S_1 : RDF + FYM (25t/ha)
S_2 : FYM (50%) + Vermicompost (50%)
S_3 : FYM (50%) + Vermicompost (50%) + Neemcake (500 kg/ha)
S_4 : FYM (50%) + Vermicompost (50%) + *Azospirillum* + PSB (5 kg/ha)

Foliar application (F)
F_1 : Panchagavya(5%)
F_2 : Vermiwash (5%)
F_3 : NAA (10 ppm)
F_4 : Control (Water spray)
NS : Non-significant

Table 5. Effect of soil application and foliar spray of organics on number of leaves at different stages of crop growth in capsicum

Treatments	45 DAT					90 DAT					harvest				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
S_1	27.6	25.87	26.53	28.77	27.19	60.13	54.33	59.87	55.33	57.42	63.67	62.90	67.40	62.80	64.19
S_2	28.8	26.93	27.07	29.27	28.02	55.93	59.67	61.33	56.80	58.43	65.73	70.33	66.67	65.93	67.17
S_3	33.6	28.13	25.67	28.33	28.93	58.27	59.33	62.00	61.53	60.28	70.33	69.13	70.33	71.87	70.42
S_4	29.6	29.00	27.67	36.95	30.80	64.40	66.67	65.20	62.37	64.66	70.13	77.70	77.33	68.53	73.43
Mean	29.90	27.48	26.73	30.83	28.74	59.68	60.00	62.10	59.01	60.20	67.47	70.02	70.43	67.28	68.80
For comparing means of	S.Em±		CD at 5%			S.Em±		CD at 5%			S.Em±		CD at 5%		
S	0.80		2.31			0.75		2.17			0.94		2.73		
F	0.80		2.31			0.75		2.17			0.94		2.73		
SxF	1.60		NS			1.50		NS			1.89		NS		

Soil application (S)
S_1 : RDF + FYM (25t/ha)
S_2 : FYM (50%) + Vermicompost (50%)
S_3 : FYM (50%) + Vermicompost (50%) + Neemcake (500 kg/ha)
S_4 : FYM (50%) + Vermicompost (50%) + *Azospirillum* + PSB (5 kg/ha)

Foliar application (F)
F_1 : Panchagavya(5%)
F_2 : Vermiwash (5%)
F_3 : NAA (10 ppm)
F_4 : Control (Water spray)
NS : Non-significant

Similarly the number of branches differs significantly at 45, 90 DAT and at harvest, due to foliar application of NAA at the rate of 10 ppm recorded significantly more number of branches (5.47, 12.57 and 14.02) at 45, 90 DAT and at harvest respectively over control.

The interaction of soil application and foliar spray had no significant influence at all the stages of growth. However, the numbers of branches were observed with S_4F_3 (16.69).

Days to flower initiation

The data on days to flower initiation as influenced by soil application and foliar spray of organics and their interactions are presented in Table 7. The days to flower initiation differed significantly due to soil application of organics. The soil application of FYM 50 per cent + vermicompost 50 per cent + biofertilizer took 37.42 number of days as compared to RDF + FYM (25 t/ha) taken more number of days (40.42). There was no significant variation for days to flower initiation between S_2 and S_3, S_4.

There was significant differences among the treatments due to foliar spray of NAA at the rate of 10 ppm took more number of days (37.58) over control (40.75) days.

The interaction had no significant influence on days to flower initiation. The treatment combination S_4F_3 taken less number of days to flower initiation (35.33) as compared to S_1F_1.

Days to 50 per cent flowering

The days to 50 per cent flowering as influenced by soil application and foliar spray of organics and their interactions are presented in Table 7.

The days to 50 per cent flowering differs significantly due to soil application of organics.

The soil application of FYM 50 per cent + vermicompost 50 per cent + biofertilizer took less number of days (44.33) and RDF + FYM took more number of days (47.17). There was no significant variation for days to 50 per cent flowering between S_2 and S_3.

Similarly foliar spray of organics significantly influenced days to 50 per cent flowering. Among the sprays NAA at the rate of 10 ppm took less number of days to 50 per cent flowering 43.67 days whereas control taken less number days (46.50).

The interaction had no significant influence on days to 50 per cent flowering. The treatment combination S_4F_3 took more number of days to 50 per cent flowering.

4.2 YIELD PARAMETERS

Number of fruits per plant picking wise

The data on number of fruits per plant harvested at 3 stages as influenced by soil application, foliar spray and their interaction are presented in Table 8.

The number of fruits per plant differs significantly due to soil application of organics. The soil application of FYM 50 per cent + vermicompost 50 per cent + biofertilizers recorded more number of fruits per plant, at all the 3 stages of picking (4.67, 4.83, 4.35) respectively. S_3 and S_2 are on par each other at all the stages of pickings.

The number of fruits per plant differs significantly due to foliar spray of organics. The foliar spray of NAA @ 10 ppm recorded higher fruits per plant at all 3 pickings (4.25, 4.90, 4.47) followed by F_2 and F_1, respectively over control.

The number of fruits per plant did not differ significantly due to foliar spray and soil application of organics. However, S_4F_3 interaction recorded higher number of fruits per plant.

Table 6. Effect of soil application and foliar spray of organics on number of branches per plat at different stages of crop growth in capsicum

Treatments	45 DAT					90 DAT					Harvest				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
S_1	4.93	5.20	4.80	4.37	4.83	12.00	10.60	10.93	11.07	11.15	13.75	13.04	11.20	10.98	12.24
S_2	4.53	5.60	5.20	4.07	4.85	10.60	11.87	12.60	9.80	11.22	13.60	14.53	13.53	12.80	13.62
S_3	4.60	5.40	6.07	5.40	5.37	11.73	12.53	11.00	10.53	11.45	12.73	14.53	14.67	12.93	13.72
S_4	5.13	5.53	5.80	5.00	5.37	12.73	12.53	15.73	11.47	13.12	13.80	13.98	16.69	12.40	14.22
Mean	4.80	5.43	5.47	4.71	5.10	11.77	11.88	12.57	10.72	11.73	13.47	14.02	14.02	12.28	13.45

For comparing means of	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%
S	0.17	0.48	0.44	1.26	0.39	1.13
F	0.17	0.48	0.44	1.26	0.39	1.13
SxF	0.33	NS	0.87	NS	0.78	NS

Soil application (S)
S_1 : RDF + FYM (25t/ha)
S_2 : FYM (50%) + Vermicompost (50%)
S_3 : FYM (50%) + Vermicompost (50%) + Neemcake (500 kg/ha)
S_4 : FYM (50%) + Vermicompost (50%) + *Azospirillum* + PSB (5 kg/ha)

Foliar application (F)
F_1 : Panchagavya 5%
F_2 : Vermiwash 5%
F_3 : NAA 10 ppm
F_4 : Control (Water spray)
NS : Non-significant

Table 7. Effect of soil application and foliar spray of organics on days to flower initiation and days to 50 per cent flowering in capsicum

Treatments	Days to flower initiation					Days to 50 per cent flowering				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
S_1	40.67	40.00	38.67	42.33	40.42	49.00	46.67	45.67	47.33	47.17
S_2	43.67	41.67	37.67	38.33	40.33	47.67	44.33	45.00	46.00	45.75
S_3	36.00	38.33	38.67	41.67	38.67	46.00	46.33	40.67	48.00	45.25
S_4	37.33	36.33	35.33	40.67	37.42	42.33	47.00	43.33	44.67	44.33
Mean	39.42	39.08	37.58	40.75	39.21	46.25	46.08	43.67	46.50	45.63
For comparing means of	S.Em±		CD at 5%			S.Em±		CD at 5%		
S	0.75		2.16			0.66		1.90		
F	0.75		2.16			0.66		1.90		
SxF	1.49		NS			1.32		NS		

Soil application (S)
S_1 : RDF + FYM (25t/ha)
S_2 : FYM (50%) + Vermicompost (50%)
S_3 : FYM (50%) + Vermicompost (50%) + Neemcake (500 kg/ha)
S_4 : FYM (50%) + Vermicompost (50%) + *Azospirillum* + PSB (5 kg/ha)

Foliar application (F)
F_1 : Panchagavya 5%
F_2 : Vermiwash 5%
F_3 : NAA 10 ppm
F_4 : Control (Water spray)
NS : Non-significant

Total Number of fruits per plant

The total number of fruits per plant as influenced by soil application of organics and foliar spray of organics are presented in Table 9.

The total number of fruits per plant differed significantly due to soil application of FYM 50 per cent + vermicompost 50 per cent + biofertilizer recorded more number of fruits per plant (13.85) as compared lowest seen in S_1 (9.73). The S_2 and S_3 are on par each other.

Foliar spray of organics differed significantly. The NAA @ 10 ppm produced more total number of fruits per plant (12.12) as compared to other foliar spray of F_4 (11.27). However, panchagavya (F_1) and vermiwash (F_2) are on par each other (11.50 and 11.79) respectively, whereas control produced less number of fruits (11.27).

The interaction of soil application and foliar spray had no significant influence. However, the more number of fruits were recorded with S_4F_3.

Fruit yield per plant (g)

The data on fruit yield per plant as influenced by soil application of organics and foliar spray of organic and their interactions are presented in Table 9.

The fruit yield per plant differed significantly due to the soil application of organics. The soil application of FYM 50 per cent + vermicompost 50 per cent + biofertilizer recorded significantly higher fruit + yield pr plant (380.57 g). However, S_2 and S_3 are on far each other. S_1 (RDF + FYM (25 t/ha)) recorded lowest fruit yield per plant.

Similarly the spray of organics on fruit yield per plant differ significantly the NAA @ 10 ppm recorded higher fruit yield (361.52 g) over control F_4 (307.75 g).

The interaction of soil application and foliar spray had no significant influence on fruit yield per plant. However, the highest fruit yield was recorded with S_4F_3 (427.92 g) treatment combination.

Fruit yield per plot

The data on fruit yield per plot as influenced by soil application of organics and foliar spray of organics and their interactions are presented in Table 10.

The fruit yield per plot differed significantly due to the soil application of organics. The soil application of FYM 50 per cent + vermicompost 50 per cent + biofertilizer recorded significantly higher fruit yield per plot (9.29 kg). However, S_2 and S_3 are on par each other. S_1 (RDF + FYM) recorded lower fruit yield per plot (7.46 kg).

The foliar spray of organics, the fruit yield per plot differed significantly. The foliar spray of NAA @ 10 pm was recorded higher fruit yield per plot (9.00 kg) whereas vermiwash and panchagavya are on par each other (8.10 kg and 7.80 kg) respectively over control F_4 (7.78 kg).

However, the interaction of soil application and foliar spray had no significant influence on fruit yield per plot. The numerically higher fruit yield was recorded with S_4F_3 (10.93 kg/plot).

Fruit yield per ha (tonnes)

The data on fruit yield per hectare as influenced by soil application and foliar spray of organics and their interactions are presented in the Table 10 and plates 3,4and5.

The fruit yield per hectare differed significantly due to soil application of organics. The soil application of FYM 50 per cent + vermicompost 50 per cent + biofertilizer recorded higher fruit yield (13.99 tonnes) S_2 and S_3 are on par each other (11.79 t and 12 t/ha) respectively. The lowest fruit yield noticed at S_1 (11.03 t/ha).

Table 8. Effect of soil application and foliar spray of organics on number of fruits at first, second and third picking

Treatments	Number of fruits at first picking					Number of fruits at second picking					Number of fruits at third picking				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
S_1	3.67	3.00	3.27	2.93	3.22	3.80	3.60	3.47	3.07	3.48	3.07	2.67	3.53	2.87	3.03
S_2	3.00	3.40	3.80	2.77	3.24	4.33	3.60	4.00	3.07	3.75	3.40	3.73	5.07	3.53	3.93
S_3	3.93	4.07	3.40	3.07	3.62	4.27	5.67	5.13	3.40	4.62	3.27	5.33	4.53	2.67	3.95
S_4	4.00	4.33	6.53	3.80	4.67	4.53	4.27	7.00	3.53	4.83	4.07	4.07	4.73	4.53	4.35
Mean	3.65	3.70	4.25	3.14	3.69	4.23	4.28	4.90	3.27	4.17	3.45	3.95	4.47	3.40	3.82
For comparing means of	S.Em±		CD at 5%			S.Em±		CD at 5%			S.Em±		CD at 5%		
S	0.24		0.69			0.37		1.07			0.25		0.73		
F	0.24		0.69			0.37		1.07			0.25		0.73		
SxF	0.48		NS			0.74		NS			0.51		NS		

Soil application (S)
S_1 : RDF + FYM (25t/ha)
S_2 : FYM (50%) + Vermicompost (50%)
S_3 : FYM (50%) + Vermicompost (50%) + Neemcake (500 kg/ha)
S_4 : FYM (50%) + Vermicompost (50%) + *Azospirillum* + PSB (5 kg/ha)
Azospirillum + PSB (5 kg/ha)

Foliar application (F)
F_1 : Panchagavya 5%
F_2 : Vermiwash 5%
F_3 : NAA 10 ppm
F_4 : Control (Water spray)
NS : Non-significant

Table 9. Effect of soil application and foliar spray of organics on total number of fruits per plant and fruit yield per plant

Treatments	Total number of fruits per plant					Fruit yield per plant(g)				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
S_1	10.10	9.53	9.77	9.53	9.73	281.33	341.86	304.22	297.45	306.22
S_2	10.37	11.00	12.00	10.30	10.92	306.43	304.26	339.88	293.96	311.13
S_3	11.65	12.80	12.16	12.15	12.19	319.60	334.00	374.05	310.14	334.45
S_4	13.90	13.85	14.56	13.10	13.85	367.71	397.20	427.92	329.45	380.57
Mean	11.50	11.79	12.12	11.27	11.67	318.77	344.33	361.52	307.75	333.09
For comparing means of	S.Em±		CD at 5%			S.Em±		CD at 5%		
S	0.43		1.24			12.16		35.11		
F	0.43		1.24			12.16		35.11		
SxF	0.86		NS			24.31		NS		

Soil application (S)
S_1 : RDF + FYM (25t/ha)
S_2 : FYM (50%) + Vermicompost (50%)
S_3 : FYM (50%) + Vermicompost (50%) + Neemcake (500 kg/ha)
S_4 : FYM (50%) + Vermicompost (50%) + *Azospirillum* + PSB (5 kg/ha)

Foliar application (F)
F_1 : Panchagavya 5%
F_2 : Vermiwash 5%
F_3 : NAA 10 ppm
F_4 : Control (Water spray)
NS : Non-significant

Table 10. Effect of soil application and foliar spray of organics on fruit yield per plot and fruit yield per ha in capsicum

Treatments	Fruit yield per plot (kg)					Fruit yield per ha (t)				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
S_1	7.42	7.65	7.59	7.18	7.46	10.97	11.31	11.21	10.64	11.03
S_2	7.44	7.95	8.53	7.97	7.97	11.01	11.76	12.61	11.79	11.79
S_3	8.10	7.42	8.97	7.58	8.02	12.98	11.24	12.56	11.21	12.00
S_4	8.22	9.63	10.93	8.38	9.29	12.14	15.09	16.33	12.39	13.99
Mean	7.80	8.16	9.00	7.78	8.19	11.78	12.35	13.18	11.51	12.20
For comparing means of	S.Em±		CD at 5%			S.Em±		CD at 5%		
S	0.31		0.91			0.43		1.23		
F	0.31		0.91			0.43		1.23		
SxF	0.63		NS			0.85		NS		

Soil application (S)
S_1 : RDF + FYM (25t/ha)
S_2 : FYM (50%) + Vermicompost (50%)
S_3 : FYM (50%) + Vermicompost (50%) + Neemcake (500 kg/ha)
S_4 : FYM (50%) + Vermicompost (50%) + *Azospirillum* + PSB (5 kg/ha)

Foliar application (F)
F_1 : Panchagavya 5%
F_2 : Vermiwash 5%
F_3 : NAA 10 ppm
F_4 : Control (Water spray)
NS : Non-significant

The foliar spray of organics on fruit yield per hectare differed significantly. The NAA @ 10 ppm recorded higher fruit yield (13.28 t/ha) over control F_4 (11.03).

However, the interaction of soil application and foliar spray of organics did not differ significantly. However S_4F_3 produced more fruit yield per hectare (16.33 t/ha).

Number of seeds per fruit

Number of seeds per fruit as influenced by soil application and foliar spray of organics and their interactions are presented in Table 11.

The number of seeds per fruit differs significantly due to soil application of organics. The soil application with FYM 50 per cent + vermicompost 50 per cent + biofertilizer was recorded more number of seeds per fruit (137.18), S_2 and S_3 (113.90 and 126.77) respectively as compared to less number of seeds per fruit recorded in S_1 (113.32) RDF + FYM (25 t/ha).

The number of seeds per fruit significantly influenced due to foliar application of organics. The application of NAA @ 10 ppm recorded more number of seeds per fruit (128.78), vermiwash and panchagavya are on par each other (128.25 and 119.30) respectively whereas less number of seeds were seen in control (114.73).

The interaction due to foliar spray and soil application of organics had no significant influence on number of seeds per fruit. However, the interaction of S_4F_3 recorded more number of seeds per fruit (152.63).

Seed weight per plant

The data on seed weight per plant as influenced by soil application of organics foliar spray of organics and their interactions are presented in Table 11.

The seed weight per plant differs significantly due to organic application. The soil application of organics FYM 50 per cent + vermicompost 50 per cent + biofertilizer was produced higher seed weight per plant (13.35 g) and S_2 and S_3 (11.40 g and 8.54 g) respectively which were on par to each other less seed weight production S_1 (8.23 g).

Foliar spray of organics differed significantly due to foliar spray of NAA @ 10 ppm (11.93 g) followed by vermiwash and panchagavya (9.99 g and 9.96 g) respectively over control F_4 (9.64 g).

The interaction of soil application and foliar spray of organics had no significant influence on the seed weight per plant. However, the highest seed weight per plant was seen in S_4F_3 (17.49 g).

Seed yield per plot (g)

The data on seed yield per plant influenced by the soil application and foliar spray of organics and their interactions are presented in Table 12.

The soil application of organics varied significantly due to soil application. The treatment of FYM 50 per cent + vermicompost 50 per cent + biofertilizer was recorded higher seed yield per plant per plot (321.40 g). Whereas S_2 and S_3 (187.48 g and 277.82 g) respectively, while lowest seed yield was seen in S_1 (187.35 g).

The foliar spray of organics differs significantly. The foliar spray of NAA at the rate of 10 ppm was recorded higher seed yield per plant (280.67 g) vermiwash and panchagavya recorded (236.60 g and 231.60 g) respectively over control F_4 (225.18).

The interaction due to soil application and foliar spray had no significant difference with respect to seed yield per plant. However, the treatment of S_4F_3 recorded higher seed yield.

Table 11. Effect of soil application and foliar spray of organics on number of seeds per fruit and seed weight per plant in capsicum

Treatments	Number of seeds per fruit					Seed weight per plant (g)				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
S_1	106.87	120.67	120.80	104.53	113.22	8.72	8.13	8.39	7.66	8.23
S_2	116.67	117.00	116.20	105.73	113.90	7.56	8.18	10.37	8.06	8.54
S_3	129.07	134.33	125.47	118.20	126.77	12.09	9.44	11.46	12.61	11.40
S_4	124.60	141.00	152.63	130.47	137.18	11.46	14.21	17.49	10.23	13.35
Mean	119.30	128.25	128.78	114.73	122.76	9.96	9.99	11.93	9.64	10.38
For comparing means of	S.Em±		CD at 5%			S.Em±		CD at 5%		
S	3.21		9.28			0.61		1.75		
F	3.21		9.28			0.61		1.75		
SxF	6.43		NS			1.21		NS		

Soil application (S)
S_1 : RDF + FYM (25t/ha)
S_2 : FYM (50%) + Vermicompost (50%)
S_3 : FYM (50%) + Vermicompost (50%) + Neemcake (500 kg/ha)
S_4 : FYM (50%) + Vermicompost (50%) + *Azospirillum* + PSB (5 kg/ha)

Foliar application (F)
F_1 : Panchagavya 5%
F_2 : Vermiwash 5%
F_3 : NAA 10 ppm
F_4 : Control (Water spray)
NS : Non-significant

Seed yield per ha

The data on seed yield per hectare as influenced by soil application and foliar spray of organics and their interactions are presented in Table 12.

Seed yield per ha differed significantly due to soil application of organics. Significantly higher seed yield per ha (475.31 kg) was obtained due to soil application of FYM 50 per cent + vermicompost + biofertilizer over the S_1 (RDF + FYM 25 t/h) (291.99 kg) and was on par with S_3 and S_2 (373.66 kg and 318.26 kg) respectively.

The seed yield per ha differed significantly due to foliar spray of organics. The foliar spray of NAA at the rate of 10 ppm recorded higher seed yield per ha (414.82 kg) over control (328.97 kg) S_1.

The interaction of foliar spray and soil application did not differed significantly. However the highest yield was noticed in S_4F_3 (576.64 kg).

100 seed weight (g)

The data on 100 seed weight as influenced by soil application and foliar spray of organics and their interactions are presented in Table 12.

Hundred seed weight differed significantly due to soil application of organics. Significantly higher 100 seed weight (0.83 g) was obtained due to soil application of FYM 50 per cent + vermicompost + biofertilizer over the S_1 (RDF + FYM 25 t/ha) (0.71 g) and was on par with S_3 and S_2 (0.73 g and 0.72 g) respectively.

The 100 seed weight differed significantly due to foliar spray of organics. The foliar spray of NAA at the rate of 10 ppm recorded higher 100 seed weight (0.83 g) over control (0.70 kg) S_1.

The interaction of foliar spray and soil application did not differed significantly.

Leaf curl index

The data on leaf curl index at 45, 90 days after transplanting as influenced by soil application as foliar spray of organics and their interactions are presented in the Table 13.

The leaf curl index differs significantly due to soil application of organics at 45 and 90 DAT. The soil application of FYM 50 per cent + vermicompost 50 per cent + neem cake (S3) recorded significantly lower leaf curl index of 45, 90 days after transplanting (0.61, 0.78) respectively over S_1 (RDF + FYM (25 t/ha). However, S_2 and S_4 were on par with each other except at harvest.

Foliar application significantly influenced the leaf curl index at 45, 90 DAT . The foliar application of NAA at the rate of 10 ppm recorded significantly lower leaf curl index (0.66, 0.91) at 45, 90 DAT (F_4) control. (0.76and1.09 respectively).

The interactions due to soil application and foliar spray had no significance at leaf curl index on crop growth.

4.3 QUALITY PARAMETERS

Germination (%)

The data on seed germination as influenced by foliar spray and soil application of organics and their interactions are depicted in Table 14.

Germination percentage varied significantly due to soil application of organics. The higher seed germination has been noticed in FYM 50 per cent + vermicompost 50 per cent + biofertilizer (93.42%) and was on par with S_3 and S_2 (91.50 and 91.08%) and lower germination was seen in S_1 (90.67%).

Table 12. Effect of soil application and foliar spray of organics on seed weight per plot, seed yield per ha and 100 seed weight

Treatments	Seed weight per plot (g)					Seed yield per ha					100 seed weight				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
S_1	192.67	171.08	209.67	176.00	187.35	282.78	277.94	310.15	297.08	291.99	0.66	0.69	0.74	0.75	0.71
S_2	182.00	193.83	208.92	165.17	187.48	296.81	301.90	395.73	278.59	318.26	0.67	0.76	0.73	0.67	0.71
S_3	236.08	315.17	269.58	290.45	277.82	452.14	348.61	376.74	317.13	373.66	0.73	0.72	0.82	0.68	0.74
S_4	315.67	266.33	434.50	269.08	321.40	413.38	488.15	576.64	423.07	475.31	0.83	0.73	1.03	0.72	0.83
Mean	231.60	236.60	280.67	225.18	243.51	354.15	361.28	414.82	328.97	364.80	0.72	0.73	0.83	0.70	0.75
For comparing means of	S.Em±		CD at 5%			S.Em±		CD at 5%			S.Em±		CD at 5%		
S	14.34		41.42			17.93		51.79			0.02		0.07		
F	14.34		41.42			17.93		51.79			0.02		0.07		
SxF	28.68		NS			35.87		NS			0.05		NS		

Soil application (S)
S_1 : RDF + FYM (25t/ha)
S_2 : FYM (50%) + Vermicompost (50%)
S_3 : FYM (50%) + Vermicompost (50%) + Neemcake (500 kg/ha)
S_4 : FYM (50%) + Vermicompost (50%) + *Azospirillum* + PSB (5 kg/ha)

Foliar application (F)
F_1 : Panchagavya 5%
F_2 : Vermiwash 5%
F_3 : NAA 10 ppm
F_4 : Control (Water spray)
NS : Non-significant

Table 13. Effect of soil application and foliar spray of organics on leaf curl index at 45 and 90 DAT

Treatments	Leaf curl index at 45 DAT					Leaf curl index at 90 DAT				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
S_1	0.77	0.80	0.73	0.72	0.75	0.93	1.55	0.91	1.33	1.18
S_2	0.75	0.74	0.68	0.84	0.75	1.10	0.97	1.04	1.29	1.10
S_3	0.59	0.61	0.58	0.68	0.61	0.91	0.49	0.83	0.91	0.78
S_4	0.72	0.70	0.66	0.80	0.72	1.14	0.72	0.87	0.85	0.90
Mean	0.71	0.71	0.66	0.76	0.71	1.02	0.93	0.91	1.09	0.99

For comparing means of	S.Em±	CD at 5%	S.Em±	CD at 5%
S	0.01	0.04	0.02	0.07
F	0.01	0.04	0.02	0.07
SxF	0.03	NS	0.05	NS

Soil application (S)
S_1 : RDF + FYM (25t/ha)
S_2 : FYM (50%) + Vermicompost (50%)
S_3 : FYM (50%) + Vermicompost (50%) + Neemcake (500 kg/ha)
S_4 : FYM (50%) + Vermicompost (50%) + *Azospirillum* + PSB (5 kg/ha)

Foliar application (F)
F_1 : Panchagavya 5%
F_2 : Vermiwash 5%
F_3 : NAA 10 ppm
F_4 : Control (Water spray)
NS : Non-significant

Table 14. Effect of soil application and foliar spray of organics on germination percentage and shoot length of seedling in capsicum

Treatments	Germination (%)					Shoot length (cm)				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
S_1	91.00 (72.93)	90.67 (72.24)	92.00 (73.64)	89.00 (70.66)	90.67 (72.37)	4.47	5.20	5.00	4.70	4.84
S_2	91.00 (72.60)	90.67 (72.24)	93.00 (74.72)	89.67 (71.30)	91.08 (72.71)	5.03	4.73	5.20	4.57	4.88
S_3	92.33 (73.94)	94 (75.84)	90.33 (71.91)	89.33 (70.96)	91.50 (73.16)	4.90	5.20	5.07	5.17	5.08
S_4	94.33 (76.26)	91.67 (73.25)	95.00 (77.11)	92.67 (74.70)	93.42 (75.33)	5.23	5.33	5.83	4.87	5.32
Mean	92.17 (73.93)	91.75 (73.39)	92.58 (74.35)	90.17 (71.90)	91.67 (73.39)	4.91	5.12	5.28	4.83	5.03

For comparing means of	Germination (%)		Shoot length (cm)	
	S.Em±	CD at 5%	S.Em±	CD at 5%
S	0.57	1.64	0.11	0.32
F	0.57	1.64	0.11	0.32
SxF	1.14	NS	0.22	NS

Figures in parenthesis indicate arcsine transformed values

Soil application (S)
S_1 : RDF + FYM (25t/ha)
S_2 : FYM (50%) + Vermicompost (50%)
S_3 : FYM (50%) + Vermicompost (50%) + Neemcake (500 kg/ha)
S_4 : FYM (50%) + Vermicompost (50%) + *Azospirillum* + PSB (5 kg/ha)

Foliar application (F)
F_1 : Panchagavya 5%
F_2 : Vermiwash 5%
F_3 : NAA 10 ppm
F_4 : Control (Water spray)
NS : Non-significant

Germination differs significantly due to foliar spray of organics. The foliar spray of NAA @ 10 ppm recorded higher germination (92.58%) over control F1 (90.17).

However, the interactions were found non-significant but numerically higher germination was found in S_4F_3 (95%).

Shoot length (cm)

The data on shoot length as influenced by soil application, foliar spray of organic sand their interactions are presented in Table 14.

The shoot length differs significantly due to soil application of organics. The soil application with FYM 50 per cent + vermicompost + 50 per cent + biofertilizer recorded significantly highest shoot length (5.32 cm) and was on far with S_2 and S_3.

The shoot length varied significantly due to foliar spray of organics. The foliar spray with NAA at the rate of 10 ppm recorded higher shoot length (5.28 cm) and it was on par with vermiwash and panchagavya (5.12 cm and 4.91 cm) respectively over control F_4 (4.83 cm).

The shoot length did not differed significantly due to interaction effect of soil application and foliar spray of organics. However, higher shoot length was noticed with S_4F_3 (5.83 cm) and lower shoot length was noticed in S_2F_4 (4.57 cm).

Root length (cm)

The results of root length due to the soil application and foliar spray of organics and their interactions are presented in Table 15.

The root length varied significantly due to soil application of organics. The soil application of FYM 50 per cent + vermicompost 50 per cent + biofertilizer recorded higher root length (5.62 cm) followed by S_2 and S_3 (5.27 cm and 5.18 cm), while S_1 produced lowest root length (5.06 cm).

The results due to foliar spray of organics differed significantly. The foliar spray of with NAA at the rate of 10 ppm recorded higher root length (5.49 cm) and lowest root length was seen in control F_4 (5.03 cm).

However, the interaction effect did not differed significantly. But the higher root length was noticed with the interaction of S_4F_3 (5.94 cm).

Seedling vigour index

The data on vigour index as influenced by soil application and foliar spray of organics presented in Table 15.

The vigour index differed significantly due to soil application of organics. The soil application of FYM 50 per cent + vermicompost 50 per cent + biofertilizer recorded higher seedling vigour index (1002) followed by (940 and 912) S_3 and S_2 respectively.

However, there is significant difference among foliar sprays. The NAA @ 10 ppm recorded higher seedling vigour (997) and lower seedling vigour index was seen in control (853).

There was no significant interaction effect between soil application and foliar spray of organics on seedling vigour index. However, higher seedling vigour index recorded in S_4F_3 (1106).

Electrical conductivity

The data on electrical conductivity as influenced by soil treatments and foliar spray and their interaction are presented in Table 16.

Table 15. Effect of soil application and foliar spray of organics on root length and seedling vigour index in capsicum

Treatments	Root length (cm)					Seedling vigour index				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
S_1	5.10	5.13	5.07	4.92	5.06	889	940	912	861	901
S_2	4.78	5.54	5.37	5.05	5.18	998	899	990	760	912
S_3	5.47	4.80	5.60	5.20	5.27	890	981	980	910	940
S_4	5.29	6.30	5.94	4.96	5.62	950	1074	1106	877	1002
Mean	5.16	5.44	5.49	5.03	5.28	932	973	997	852	939

For comparing means of	Root length (cm)		Seedling vigour index	
	S.Em±	CD at 5%	S.Em±	CD at 5%
S	0.13	0.37	26.12	75.45
F	0.13	0.37	26.12	75.45
SxF	0.26	NS	52.55	NS

Soil application (S)
S_1 : RDF + FYM (25t/ha)
S_2 : FYM (50%) + Vermicompost (50%)
S_3 : FYM (50%) + Vermicompost (50%) + Neemcake (500 kg/ha)
S_4 : FYM (50%) + Vermicompost (50%) + *Azospirillum* + PSB (5 kg/ha)

Foliar application (F)
F_1 : Panchagavya 5%
F_2 : Vermiwash 5%
F_3 : NAA 10 ppm
F_4 : Control (Water spray)
NS : Non-significant

Table 16. Effect of soil application and foliar spray of organics on electrical conductivity and seedling dry weight

Treatments	Electrical conductivity (dSm^{-1})					Seedling dry weight (mg)				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
S_1	0.463	0.430	0.462	0.464	0.455	43.04	43.29	43.35	43.33	43.25
S_2	0.424	0.417	0.421	0.419	0.420	43.41	43.43	43.68	43.00	43.38
S_3	0.428	0.390	0.321	0.452	0.407	42.94	43.66	44.01	43.47	43.52
S_4	0.358	0.361	0.331	0.390	0.366	43.85	43.79	43.54	43.40	43.64
Mean	0.413	0.401	0.384	0.431	0.417	43.31	43.54	43.64	43.30	43.45
For comparing means of	S.Em±		CD at 5%			S.Em±		CD at 5%		
S	0.01		0.031			0.10		0.28		
F	0.01		0.031			0.10		0.28		
SxF	0.02		NS			0.19		NS		

Soil application (S)
S_1 : RDF + FYM (25t/ha)
S_2 : FYM (50%) + Vermicompost (50%)
S_3 : FYM (50%) + Vermicompost (50%) + Neemcake (500 kg/ha)
S_4 : FYM (50%) + Vermicompost (50%) + *Azospirillum* + PSB (5 kg/ha)

Foliar application (F)
F_1 : Panchagavya 5%
F_2 : Vermiwash 5%
F_3 : NAA 10 ppm
F_4 : Control (Water spray)
NS : Non-significant

The electrical conductivity differs significantly due to soil application of organics. The soil application of FYM 50 per cent + vermicompost 50 per cent + biofertilizer recorded lower electrical conductivity of 0.366 dSm^{-1} compared to S_1 (RDF + FYM 25 t/ha) (0.455 dSm^{-1}).

Similarly the electrical conductivity differs significantly due to foliar spray of organics. The NAA @ 10 ppm recorded lower electrical conductivity (0.384 dSm^{-1}) and higher EC were seen in (0.431 dSm^{-1}) control (F_4).

However, the electrical conductivity did not differ significantly due to interaction of foliar spray and soil application of organics. The interaction of S_4F_3 recorded less electrical conductivity (0.331 dSm^{-1}).

Seedling dry weight (mg)

The data on seedling dry weight as influenced by application of soil organics and foliar spray of organics and their interactions are presented in Table 16.

The seedling dry weight as influenced by soil application of organics differed significantly. The soil application of FYM 50 per cent + vermicompost 50 per cent + biofertilizer produced more seedling dry weight (43.64 mg) and S_2 and S_3 are on par each other (43.38 mg and 43.52 mg) respectively.

The seedling dry weight as influenced by foliar spray of organics varied significantly. The foliar spray of NAA @ 10 ppm has recorded higher seedling dry weight (43.64 mg) followed by F_2 (43.54 mg) and lowest seedling dry weight (43.30 mg) was observed in control (F_4).(43.50 mg)

However, the interaction did not differ significantly. However, the interaction of S_4F_3 recorded higher seedling dry weight (43.54 mg).

4.4 ECONOMICS

The data on economics of organic seed production in capscicum as influenced by soil and foliar spray of organics are presented in this Table 17.

The soil application and foliar spray of FYM 50 per cent + vermicompost 50 per cent + neem cake (S3) and NAA @ 10 ppm has higher gross and net returns of Rs.17,29,920. and B:C ratio of 49.47 followed by FYM 50 per cent + vermicompost 50 per cent + biofertilizer an d foliar spray of NAA @ 10 ppm has gross returns of Rs.11,87,190.

The application with RDF+FYM (25 t/ha) and foliar spray with water (control) has lower gross returns of Rs.83, 820 and B: C ratio of 28.73.

Table 17. Economics of organic seed production in capsicum

Treatments	Gross returns (Rs/ha)	Cost of cultivation (Rs/ha)	Net returns (Rs/ha)	B:C ratio
S_1F_1	848340	29070	819270	29.18
S_1F_2	891250	29220	862030	30.50
S_1F_3	930460	30220	900240	30.79
S_1F_4	833820	29020	804800	28.73
S_2F_1	1356420	29070	1327350	46.66
S_2F_2	951390	29320	922070	32.45
S_2F_3	1130220	30220	1100000	37.40
S_2F_4	1045830	28220	1017610	37.06
S_3F_1	1240140	33970	1206170	36.51
S_3F_2	1269200	34020	1235180	37.31
S_3F_3	1729920	34970	1694950	49.47
S_3F_4	1464440	32970	1431470	44.42
S_4F_1	890440	29270	861170	30.42
S_4F_2	835770	29420	806350	28.41
S_4F_3	1187190	29720	1157470	39.95
S_4F_4	905710	28220	877490	32.09
S.Em±	107595.97	-	106595.97	3.54
CD (P=0.05)	310759.699	-	300759.699	10.224

Plate 3. At Harvest

Plate 4. Damaged Fruits

Plate 5. Matured fruits

5. DISCUSSION

A field investigation conducted on “Studies on organic seed production in capsicum” at the Agriculture Research Station, Bagalkot during summer 2007-08 and laboratory studies were made in the Department of Seed Science and Technology, University of Agricultural Sciences, Dharwad. The results obtained from the field and laboratory experiments are discussed in this chapter.

5.1 EFFECT OF SOIL APPLICATION OF ORGANICS

5.1.1 Growth parameters

There was a significant difference in plant height, number of leaves per plant and number of branches per plant due to soil application of organics (Fig 2). The soil application with FYM 50 per cent + vermicompost 50 per cent + biofertilizer resulted in significantly higher plant height (21.34, 35.19 and 42.95 cm) number of leaves per plant (30.80, 64.66 and 73.43) and number of branches per plant (5.37, 13.12 and 14.22) respectively at 45, 90 DAT and at harvest.

The increase in plant height, number of leaves, number of branches per plant may be due to FYM with narrow C: N ratio. It may be attributed to produce more humic acid and humic substances which contained in the form of chelates with phosphorous. The chelated phosphorous has been reported to be more soluble in water which could make it available to crop.

This is mainly due to FYM supplies plant nutrients through its own decomposition, forming an additional source of ammonical nitrogen (NH_4^-N) that might have resulted in increased seed yield of capsicum such results on use of FYM was reported by Velmurugan *et al.* (1993) in turmeric.

Increased growth parameters mainly ascribed to organic manures which inturn provided sufficient quantity of carbonaceous material for decomposition by microorganics, converting them to soil reserves. The beneficial effect of organic manure on yield and its attributes as well as improvement in physical and biological properties of the soil was reported by several research workers (Paramaguru *et al.*, 1993; Kamala Singh, 2001; Balasubramani *et al.*, 1997). It could also attributed to the fact that after proper decomposition and mineralization of the manures, supplied available nutrients directly to the plant and also had solubilizing effect on fixed form of nutrients in soil as reported by Sharma (2003) in carrot.

Similar results were also reported by Velumurgan *et al.* (1993), mainly increased the growth parameters due to more production of lateral roots, more symbiotic activity could have been taken place and nitrogen fixation mainly due to the application of *Azospirillum*.

Further, these results are in accordance with the findings of Sankarnaryan *et al.* (1995) in bhendi, Paramaguru *et al.* in chilli (1993), Kamala Singh (2001) in potato, Balasubramani *et al.* (1997) in bhendi.

Days to flower initiation and 50 per cent flowering was differed significantly due to soil application with FYM 50 per cent + vermicompost 50 per cent + biofertilizer. This treatment has early flower initiation and days to 50 per cent flowering (37.42 and 44.33). This might be due to enhanced production of growth promoting substances like gibberellic acid, indole acetic acid and plant growth substances. These results are in agreement with the findings of Bindiya *et al.* (2006) in cucumber.

5.1.2 Seed yield and its attributes

In fruit vegetables, the yield attributes are mainly influenced by number of factors. The yield variation due to biotic and abiotic factors like other factors which affect not only yield but also seed yield and seed quality parameters.

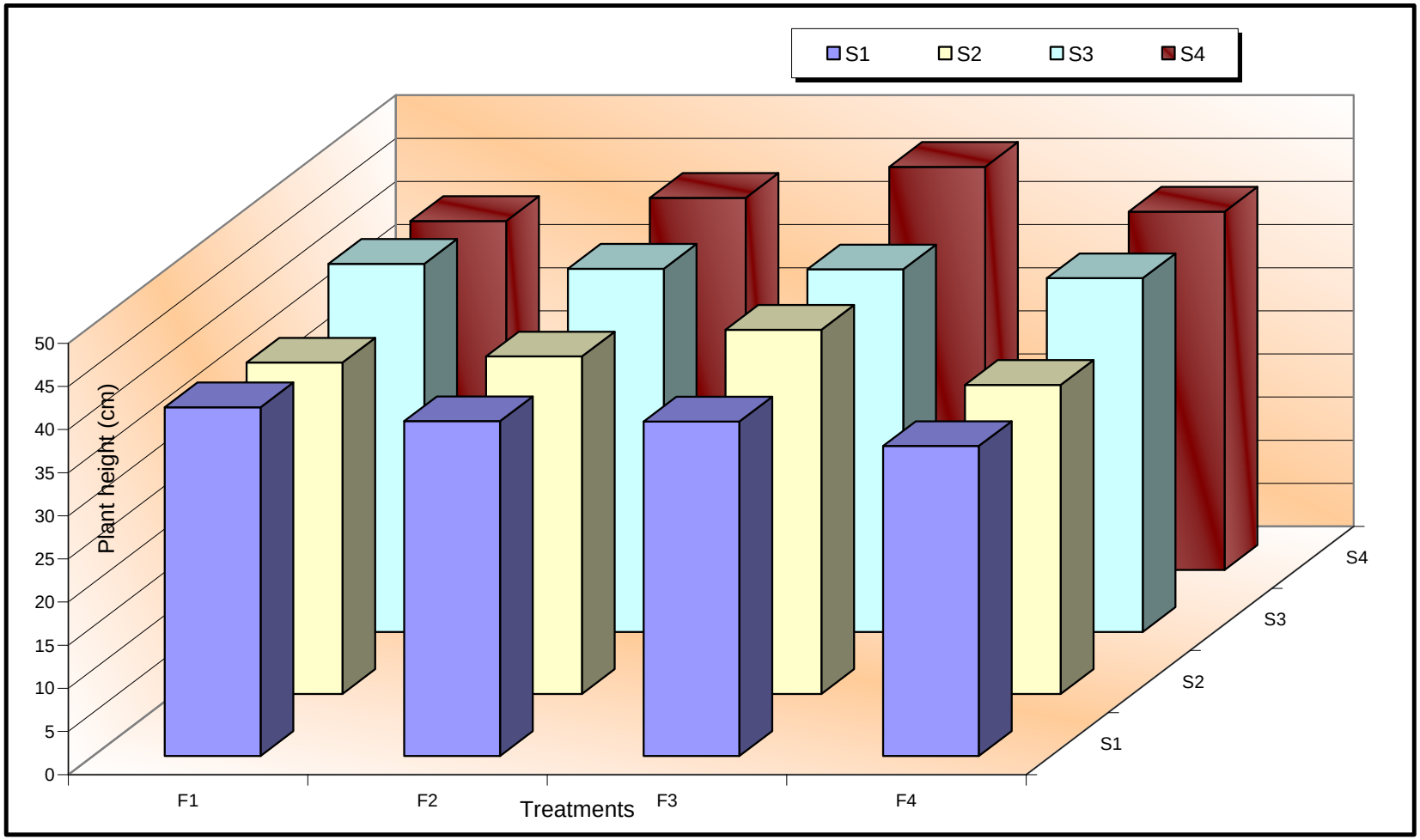

Fig. 2. Effect of soil application and foliar spray of organics on plant height (cm) at harvest

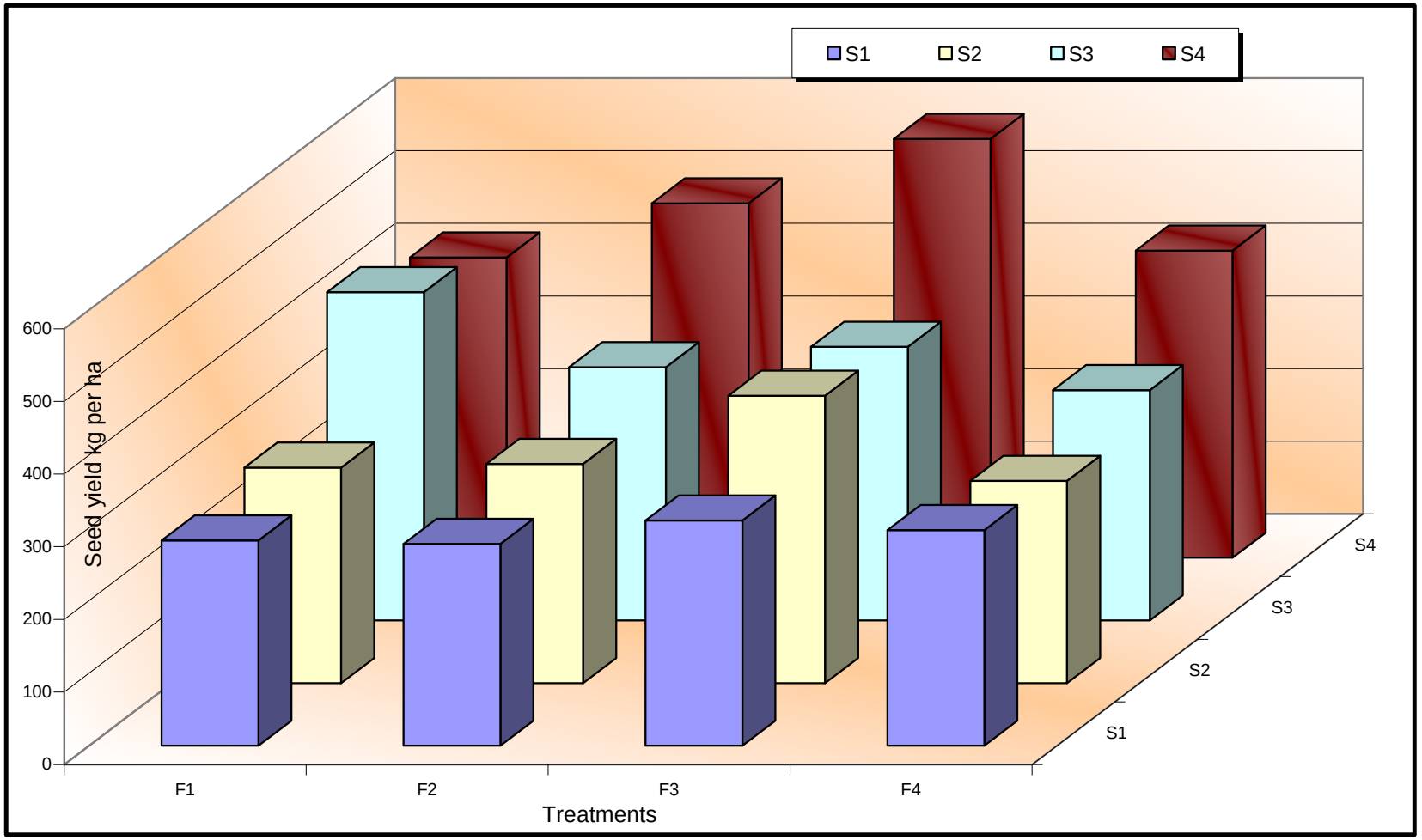

Fig. 3. Effect of soil application and foliar spray of organics on seed yield kg per ha

In the present study, the fruit yield and seed yield parameters differed significantly due to soil application of organics (Fig 3). The soil application of FYM 50 per cent + vermicompost 50 per cent + biofertilizer registered significantly higher fruit yield and seed yield. The increase in seed yield per ha (475.31 kg) may be due to contribution of yield parameters like number of seeds per fruit (137.18), seed weight per plot (321.40 g) and 100-seed weight (0.83 g)(Fig 4). The fruit yield per hectare (13.99 t) differed significantly. This is because of total number of fruits per plant (12.61), fruit yield per plant (380.57 g) and fruit yield per plot (9.29 kg).

The increase in fruit and seed yield may be due to the better source sink relationship. Further it can be stated that better performance of growth parameters. So it can be attributed to the increased growth attributes and direct role of biofertilizer in nitrogen fixation, production of phytohormones like substances and increased in uptake of nutrients might have contributed for increasing the fruit and seed yield in this treatment (Bindiya *et al.*, 2006).

Application of FYM 50 per cent and vermicompost 50 per cent + biofertilizers, might have helped to the slow release of nutrients from organic manures when supplemented with inorganic fertilizers. Further, micro-organisms might have helped in faster decomposition of organic manures there by increasing the availability of nutrients, specially protein synthesis further it was suggested that increase in fruit weight might have accelerated the mobility of photosynthates from source to the sink which was influenced by the growth hormones which released from vermicompost, the organic source (Sivakumar *et al.*, 1999 in capsicum).

The increase in seed yield and attributes were obtained in the plants which were inoculated with biofertilizers. This could be attributed to the effect of growth hormones like IAA, cytokinin produced by *Azospirillum*, auxin, gibberellin. The FYM might have enhanced the efficacy of applied N and P. The efficacy of inorganic manures was pronounced when they are combined with organic fertilizers, individually or synergistically resulted in the increased yield as was reported by Nanthakumar *et al.* (2001) in brinjal.

Azospirillum and phosphobacteria physiologically influenced the activity of number of enzymes which lead to increased cell metabolism and enzymatic activity which inturn change the biochemical composition of fruit. The enhanced absorption of nitrogen and its direct participation in protein synthesis might have been reported by Ramanathan and Subbaiah (1982) in amaranthus.

The increased yield and yield attributes due to interaction of organic and inorganic nutrients resulting in better translocation of nutrients under optimum moisture condition of the soil leading to readily availability of nutrients, increased photosynthetic activity of leaf area of the crop, inducing better growth and yield attributes of okra crop (Devender Singh *et al.*, 1997).

These results are in agreement with the findings of Parvatham *et al.* (1989) in bhendi, Kamal Singh (2001) in potato, Parmaguru *et al.* (1993) in chilli, Velumurugan *et al.* (1993) in turmeric and Duraisamy *et al.* (1999) in tomato.

5.1.3 Seed quality parameters

The effect of soil application of organics on seed quality parameters such as germination, root length, shoot length, vigour index, electrical conductivity has been discussed below.

The seed germination percentage, root length, shoot length and seedling vigour index, electrical conductivity, seedling dry weight differed significantly due to soil application of organics. The higher seed germination (93.42%), shoot length (5.32 cm), root length (5.62 cm), seedling vigour index (1001) and lower electrical conductivity (0.36 dSm^{-1}) were observed due to soil application of FYM 50 per cent + vermicompost 50 per cent + biofertilizers which was followed by FYM 50 per cent + vermicompost 50 per cent + neem cake (Fig 5 and 6) .

This might be due to better nutrient status in the soil. Better assimilation of nutrients by plants was reflected upon their reproductive health and quality of seed. Higher germination

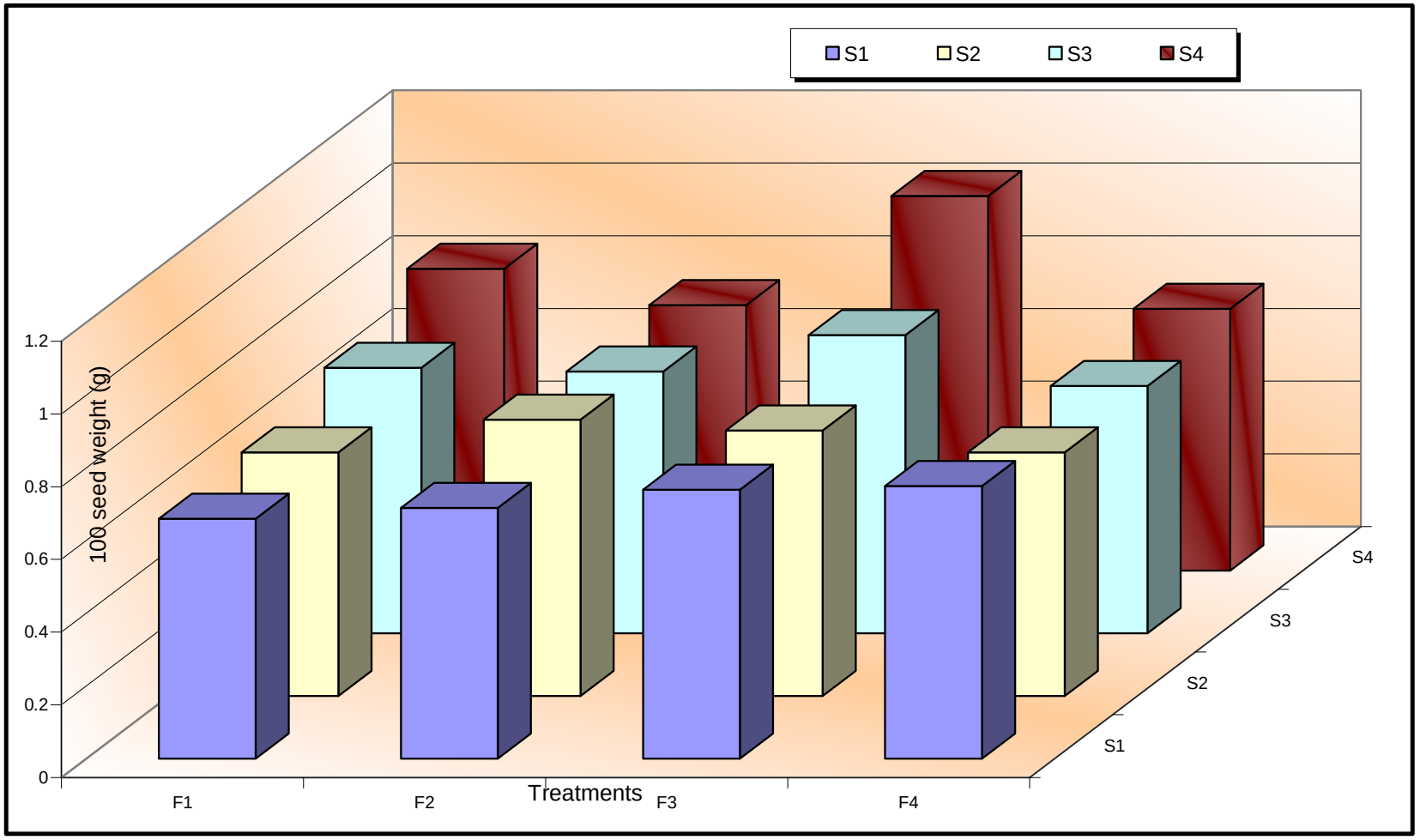

Fig 4. Effect of soil application and foliar spray of organics on 100 seed weight (g)

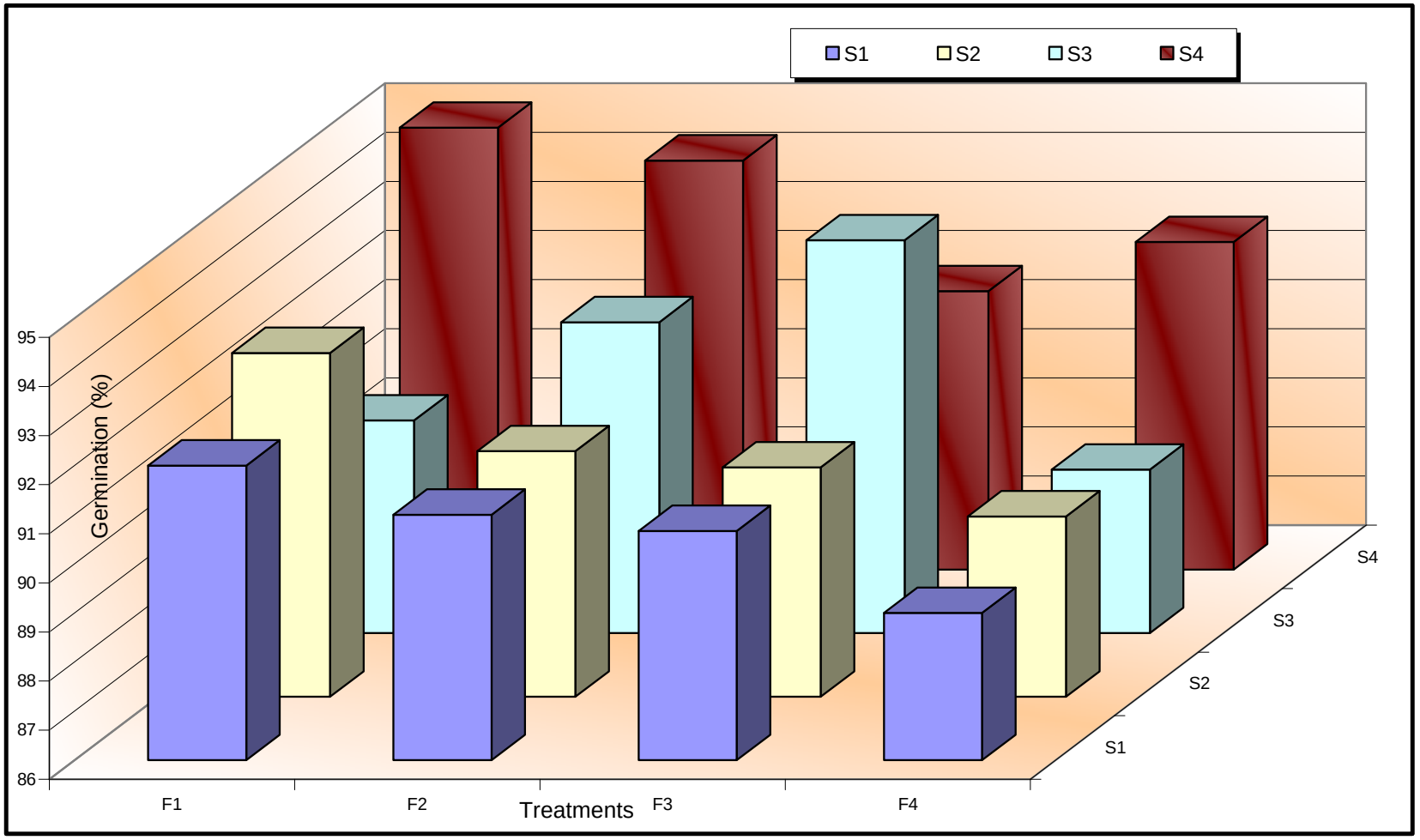

Fig. 5. Effect of soil application and foliar spray of organics on seed germination (%) of capsicum

and 100-seed weight may be more because of more availability of nitrogen in the soil for longer duration. As organics reduces the leaching losses, there is more availability of nitrogen for prolonged duration (Bodamwad *et al.*, 2006 in okra).

The higher seed yield per plant and 100 seed weight might have contributed for the higher seed quality parameters in this tretament. The application of FYM 50 per cent + vermicompost + biofertilizer. This is due to higher organic carbon, nitrogen, phosphorus and higher hormonal activity during growth stage.

5.2 EFFECT OF FOLIAR APPLICATION OF ORGANICS

5.2.1 Growth parameters

The plant height, number of leaves and number of branches per plant differed significantly due to foliar spray of NAA 10 ppm at all the stages of plant growth. The height (21.34, 36.02 and 42.44 cm), number of leaves (38.3, 62.10 and 70.43) and number of branches (5.47, 12.87 and 14.02) at 45, 90 DAT and at harvest respectively.

The increased in growth parameters due to foliar spray is mainly due to presence of growth promoting and regulatory substances and essential plant nutrients (Hannah Krujia Asangla, 2005 in banana).

5.2.2 Seed yield and its attributes

The foliar spray of organics differed significantly. The increased fruit yield and seed yield parameters may be due to presence of growth regulatory substances. The foliar spray of NAA @ 10 ppm registered higher fruit yield and seed yield and its parameters like number of seeds per fruit (128.78), seed weight per plant (11.93 g), seed yield per plot (280.67 g) and also seed yield per hectare (414.82 kg).

Number of fruits per plant (12.12), fruit yield per plant (361.52 g), fruit yield per plot (9.00 kg) fruit yield/hectare (13.18 tonnes) were increased due to NAA spray. This may be due to presence of growth promoting seed regulatory substances, cytokinins etc. physiologically influenced the activity of number of enzymes which led to increased cell metabolism enzymatic activity which inturn changed the biochemical composition (Subbaiah, 1991) in okra.

5.2.3 Seed quality attributes

The seed quality attributes like germination, root length, shoot length and vigour index, EC differed significantly the higher germination (92.58%), shoot length (5.28 cm), root length (5.49 cm) and seedling vigour index (997), electrical conductivity (0.38 dSm^{-1}) (fig.7). This may be due to presence growth regulatory substances.

5.3 INTERACTION OF SOIL AND FOLIAR APPLICATION

5.3.1 Growth parameters

The plant height, number of leaves per plant and number of branches, days to flower initiation and 50 per cent flowering did not differ significantly due to soil application and foliar spray of organics, however the interaction S_4F_3 had the plant height (21.87, 39.64 and 46.72 cm) branches per plant (5.80, 15.73 and 16.69) and leaves per plant (36.95, 65.20 and 77.33) which found superior over rest of the treatments.

5.3.2 Seed yield and yield attributes

The seed yield attributes like 100-seed weight, seed yield per plant, seed weight per plot and number of seeds did not differ significantly. But the interaction of S_4F_3 (FYM 50 per cent + vermicompost 50 per cent + biofertilizer and foliar spray of NAA @ 10 ppm) found more superior over rest of the treatments (plate 6and7).

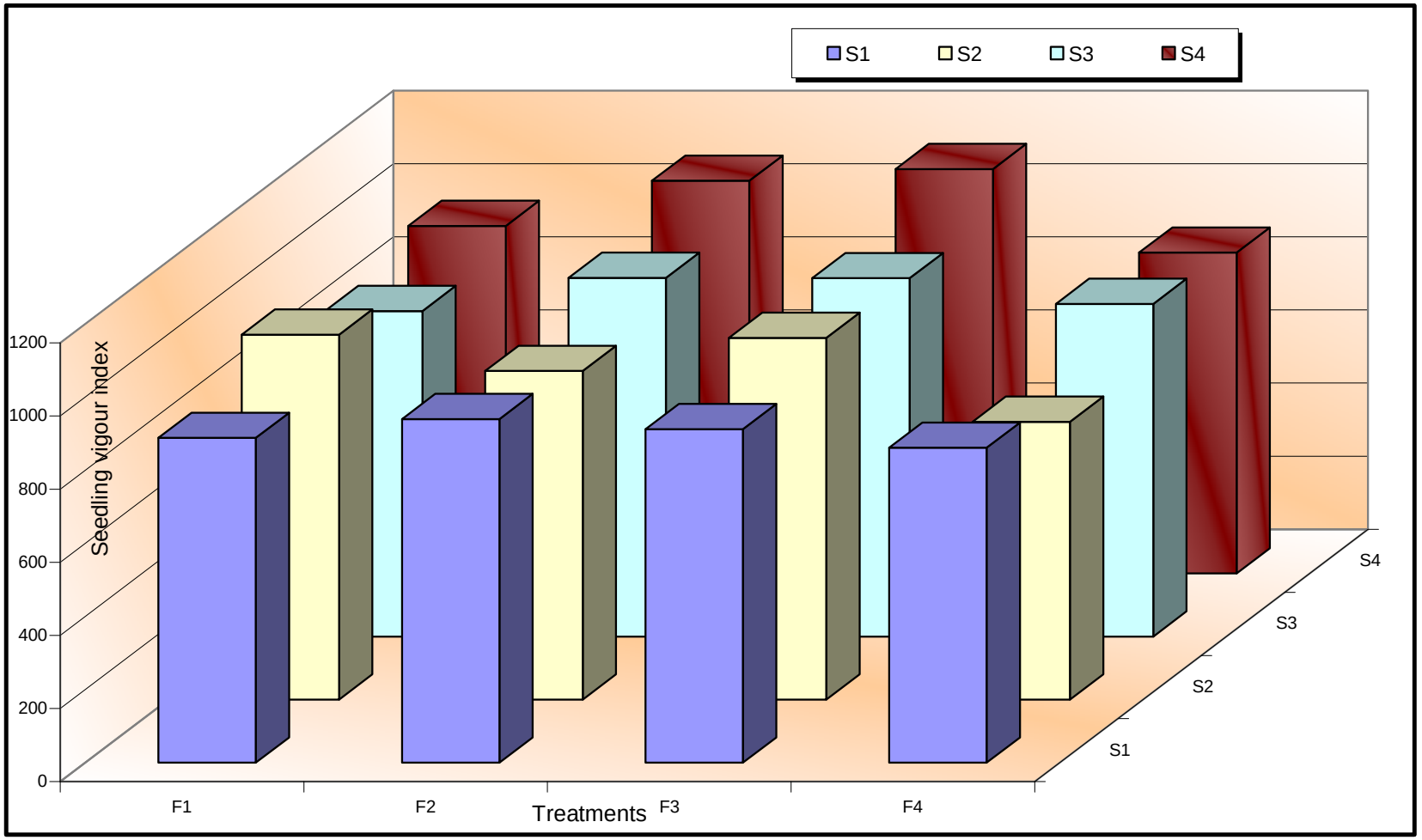

Fig. 6. Effect of soil application and foliar spray of organics on seedling vigour index

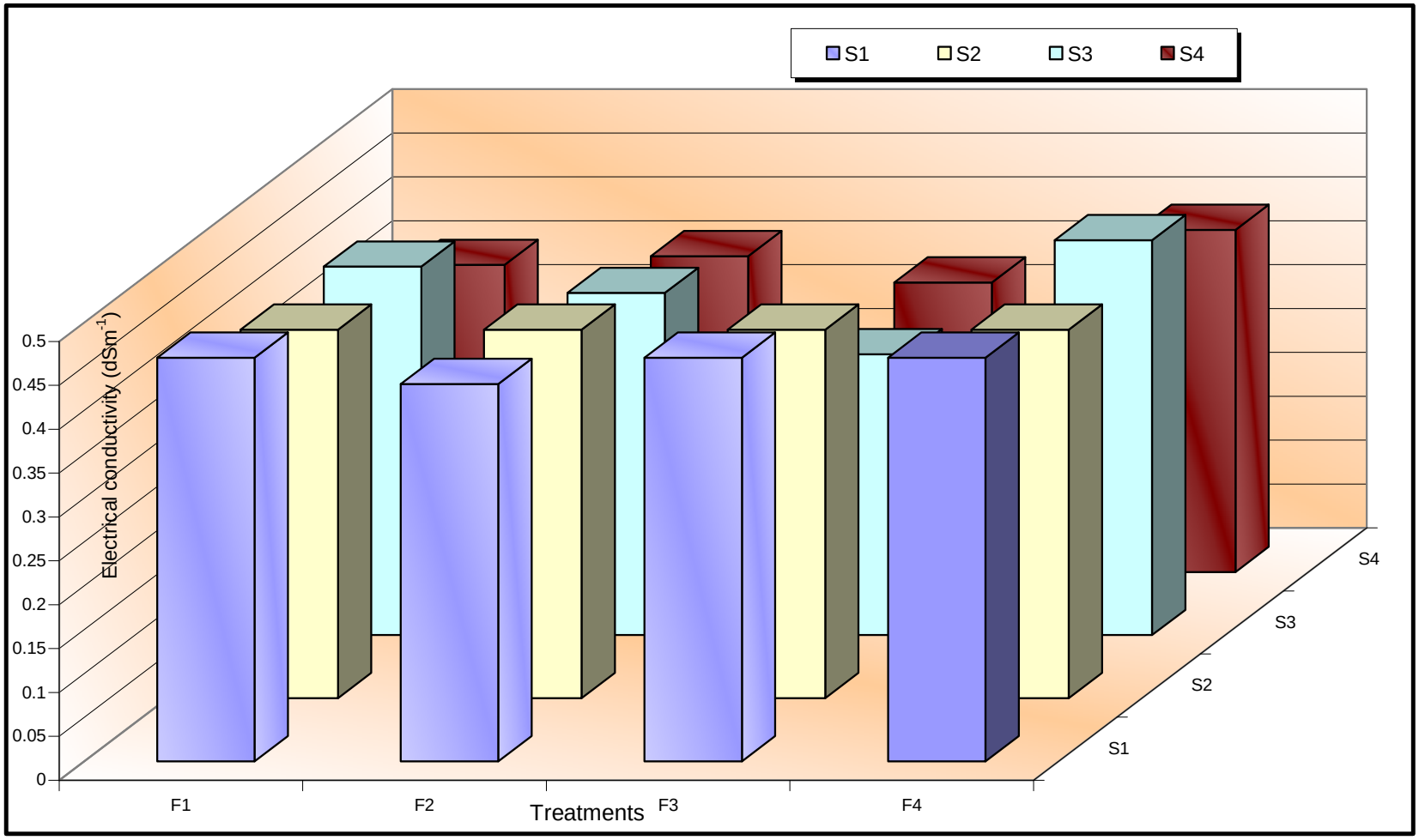

Fig. 7. Effect of soil application and foliar spray of organics on electrical conductivity (dSm-1) of seed leachate

The yield attributes like number of fruits per plant, fruit yield per plot, fruit yield per hectare, fruit yield per plant did not differ significantly however interaction of FYM 50 per cent + vermicompost 50 per cent + biofertilizer and foliar spray of NAA @ 10 ppm exhibited superior over rest of treatments.

5.3.3 Seed quality parameters

The seed quality parameters also did not differ significantly due to interaction of soil application and foliar spray of organics. However, soil application of FYM 50 per cent + vermicompost 50 per cent + biofertilizer and foliar spray of NAA @ 10 ppm found to be superior over rest of the treatments. Germination (25%), shoot length (5.83 cm), root length (5.94 cm) and seedling vigour index (1106), lower electrical conductivity (0.33 dSm^{-1}) and higher seedling dry weight (43.54 mg) were observed in above treatment (S_4F_3) (fig 7).

5.4 LEAF CURL INDEX

The leaf curl index at 45 DAT and 90 DAT differed significantly due to soil application with FYM 50 per cent + vermincompost 50 per cent + neem cake (500 kg/ha) . This treatment had lower leaf curl index (0.61) and (0.78). Leaf curl index at 45 DAT and 90 DAT differed significantly due to foliar spray. The foliar spray of NAA recorded lower leaf curl index (0.66) and (0.91). This might be due to pesticidal properties of neem cake that has reduced aphid and leaf hopper population. The results are in conformity with the findings of Shashidhara (1999) in chilli and Rajendran (1993) in bhendi.

5.5 ECONOMICS OF SEED PRODUCTION

The maximum net returns of Rs.11,57,470 were recorded in soil application of FYM 50 per cent + vermicompost 50 per cent + biofertilizer and foliar spray with NAA @ 10 ppm with benefit-cost ratio of 39.95 followed by FYM 50 per cent + vermicompost 50 per cent + neem cake 500 kg/ha, Rs.16,94,950 with benefit cost ratio of 49.47.

This could be due to full yield potential of capsicum indicating that it is essential to go for integrated nutrient management strategy rather than adopting only organic nutrient management.

5.6 PRACTICAL UTILITY OF THE RESEARCH

1. The application of FYM 50 per cent+vermicompost 50 per cent+biofertilizer @5kg/ha found effective to produce higher numbers of seeds per fruit, seed weight and 100 seed weight and quality parameters like seed yield per ha(475.31kg /ha) , germination (93.42%), seedling vigour index (1002), shoot length (5.32 cm), root length (5.62 cm), lower electrical conductivity (0.366 dSm^{-1}), followed by FYM 50 per cent + vermicompost 50 per cent + neem cake (500kg/ha) are found effective to obtain higher numbers of seeds per fruit, seed weight and 100 seed weight for seed production.

2. Number of fruits per plant, fruit yield per plant, fruit yield per plot, fruit yield per ha was higher with foliar spray of NAA @ 10 ppm (12.57, 301.52 g, 9 kg 13.18 kg) . The number of seeds per fruit, seed weight per plant, seed weight per plot, seed yield per ha was highest with foliar spray of NAA @ 10 ppm (128.78, 11.93 g, 280.67 g, 414.82 kg respectively).

5.7 FUTURE LINE OF WORK

In continuation of the present investigation the following future line of work are suggested for further research.

1. There is need to study capsicum varieties for the suitability under organic production.

2. There is a need to study the effect of botanicals and organic products with different doses to control pest and disease during seed production.

3. There is need to study the effect of drip irrigation on seed yield and quality in capsicum.
4. There is an urgent need to study the effect of organics and their combinations on nutritional quality of capsicum.

Plate 6. FYM 50 per cent + vermicompost

Plate 7. FYM 50 per cent + vermicompost 50 per cent + biofertilizer

6. SUMMARY AND CONCLUSIONS

The field investigation was carried out at Agricultural Research Station, Bagalkot and laboratory studies were conducted in the Department of Seed Science and Technology, University of Agricultural Sciences, Dharwad during 2007-08 with the objectives of effect of soil application and foliar spray of organics on growth, seed yield and quality and their interactions on capsicum. The results of the present investigation are summarized in this chapter.

Effect of soil application of organics on crop growth, seed yield and quality parameters

Soil application of FYM 50 per cent + vermicompost 50 per cent + biofertilizer recorded higher plant height (42.95) and was on par with FYM 50 per cent + vermicompost 50 per cent + neem cake @ 500 kg/ha ((41.45). Lower plant height was recorded with RDF+FYM @ 25t/ha (38.48 cm).

Soil application of S_4 (FYM 50 per cent + vermicompost 50 per cent + biofertilizer) recorded more number of leaves (73.43) and was on par with FYM 50 per cent + vermicompost 50 per cent + neem cake 500 kg/ha (70.42) lower number of leaves was recorded with (64.19) RDF+FYM @ 25t/ha.

Soil application of S_4(FYM 50 per cent + vermicompost 50 per cent + biofertilizer) (37.42) recorded less number of days to flower initiation and it was on par with S_3 (FYM 50 per cent + vermicompost 50 per cent + neem cake 500 kg/ha) (40.42).

The more number of fruits per plant was recorded in S_4(FYM 50 per cent + vermicompost 50 per cent + biofertilizer) (13.85) and S_3 (FYM 50 per cent + vermicompost 50 per cent + neem cake 500 kg/ha) which was on par with number of fruits (12.19) per plant and S_1 was recorded minimum (9.73).

The higher fruit yield per plant was recorded in FYM 50 per cent + vermicompost 50 per cent + biofertilizer (380.57 g) and S_3(FYM 50 per cent + vermicompost 50 per cent + neem cake 500 kg/ha) (334.45 g) was on par .

Higher fruit weight per plot was recorded with S_4 (FYM 50 per cent + vermicompost 50 per cent + biofertilizer) (9.29 kg) followed by S_3(FYM 50 per cent + vermicompost 50 per cent + neem cake 500 kg/ha) (8.02 kg) and lower fruit yield was noticed in S_1 (7.46 kg).

Number of seeds per fruit, seed yield per plant, seed yield per plot and seed yield per hectare was higher in FYM 50 per cent + vermicompost 50 per cent + biofertilizer (137.18, 13.35 g, 321.40 g and 475.31 kg) respectively and it was on par with FYM 50 per cent + vermicompost 50 per cent + neem cake 500 kg/ha (126.77, 11.40 g, 277.82 g, 373.66 kg).

Seed quality parameter such as germination percentage, shoot length, root length, vigour index, seedling dry weight differ significantly due to soil application of organics.

However, the higher germination was noticed in FYM 50 per cent + vermicompost 50 per cent + biofertilizer (93.42%), seedling vigour index (1002), shoot length (5.32 cm), root length (5.62 cm), lower electrical conductivity (0.366 dSm^{-1}) followed by FYM 50 per cent + vermicompost 50 per cent + neem cake 500 kg/ha and (FYM 50 per cent + vermicompost 50 per cent).

Effect of foliar spray on growth, seed yield and quality parameters

The plant height was highest in foliar spray with NAA @ 10 ppm (42.44 cm) followed by vermiwash and panchagavya and lowest plant height was seen with F_4 (40.49 cm) .

The more numbers of leaves was produced by foliar spray with NAA 10 ppm (70.43) and control recorded less number of leaves (67.28).

Days to flower initiation NAA recorded early flowering and 50 per cent flowering (37.58 and 43.67) days over control F_4.

Number of fruits per plant, fruit yield per plant, fruit yield per plot, fruit yield per ha was higher with foliar spray of NAA @ 10 ppm (12.12, 301.52 g), 9 kg 13.18 kg) over control (10.80, 307.75 g, 7.78 kg, 11.51t)

The number of seeds per fruit, seed weight per plant, seed weight per plot, seed yield per ha was highest with foliar spray of NAA @ 10 ppm (128.78, 11.93 g, 280.67 g, 414.82 kg respectively) over control.(114.73,9.64g,225.18g,328.97kg respectively).

Germination per cent, shoot length, root length and seedling vigour index, seedling dry weight are highest with foliar spray of NAA @ 10 ppm (92.58%, 5.28 cm, 5.49 cm, 997 and 43.64 mg) and lower electric conductivity (0.38 dSm^{-1}) over control(90.17%,4.83cm5.03cm852, 0.431 dSm^{-1}, 43.30mg respectively).

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APPENDIX I

Prices of inputs and outputs

Sl. No.	Particulars	Price (Rs.)
I	INPUTS	
1.	Chemical fertilizers	
a.	Urea	5.00/kg
b.	DAP	8.95/kg
c.	MOP	4.30/kg
2.	Organic manures	
a.	Vermicompost	1500.00/qtl
b.	Neem cake	1000.00/qtl
c.	Farmyard manure	300.00/t
3.	Biofertilizers	
a.	*Azospirillum*	30.00/kg
b.	PSB	30.00/kg
4.	Plant protection measures	
a.	Nimbicidine	280.00/lit
5.	Wages	
a.	Men	50.00/day
b.	Women	35.00/day
c.	Bullock pair	200.00/day
II	OUTPUT	
	Capscium seeds	3000/kg

APPENDIX II

Details of cost of cultivation in different treatments (Rs./ha)

Sl. No.	Operations	S_1F_1	S_1F_2	S_1F_3	S_1F_4	S_2F_1	S_2F_2	S_2F_3	S_2F_4	S_3F_1	S_3F_2	S_3F_3	S_3F_4	S_1F_1	S_1F_2	S_1F_3	S_1F_4
1.	Land preparation																
a.	Ploughing (tractor)	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
b.	Harrowing (bullock pair)	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
2.	Sowing																
a.	Cost of seeds	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
b.	Transplanting	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
3.	Fertilizers/manures																
a.	Cost	17850	18000	19000	17800	17850	18100	19000	17000	22750	22800	23750	21750	18050	18200	18500	17000
b.	Application charges	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
4.	Hand weeding	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
5.	Plant protection																
a.	Nimbicidine	1120	1120	1120	1120	1120	1120	1120	1120	1120	1120	1120	1120	1120	1120	1120	1120
b.	Application charges	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
6.	Harvesting, threshing, and cleaning	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500
	Cost of cultivation	29070	29220	30220	29020	29070	29320	30220	28220	33970	34020	34970	32970	29270	29420	29720	28220

INVESTIGATION ON SEED YIELD AND QUALITY AS INFLUENCED BY ORGANICS IN CAPSICUM (*Capsicum annuum*)

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ABSTRACT

A field experiment was conducted to study the effect of organic manures on growth, yield and quality of Capsicum (*Capsicum annuum*) at Agricultural Research Station Bagalkot, University of Agricultural Sciences, Dharwad during summer 2007-08. In experiment was laid out in RBD with factorial concept consisting of four organic source and their combinations while RDF + FYM kept as control.

The soil application of FYM (50%)+vermicompost (50%)+biofertilizer (5 kg/ha *Azospirillum+*5 kg/ha PSB) produced higher seed and fruit yield (475.31 kg and 13.99t). The increase in seed yield due to more number of seeds per fruit (137.18), seed weight per plot (321.40 g) and number of fruits per plant (12.61), fruit yield per plant (380.57 g), fruit yield per plot (9.29 kg), respectively and also noticed lower leaf curl index (0.61 and 0.75 at 45 and 90 DAT) respectively.

The foliar spray of NAA @ 10 ppm registered higher yield and seed yield parameters. This may be attributed increased number of seeds (128.78/fruit), seed weight (11.93 g/plant), seed yield (280.67 g/plot) and seed yield (414.82 kg/ha). Number of fruits per plant (12.57), fruit yield per plant (361.52 g), fruit yield per plot (9.00 kg) and fruit yield/hectare (13.18 tonnes). The foliar spray of NAA recorded lower leaf curl index (0.66 and 0.76 at 45 and 90 DAT, respectively).

The quality parameters like germination percentage root length, shoot length , seedling vigour index and electrical conductivity significantly influenced by organics, The higher seed germination (93.42%), shoot length (5.32 cm), root length (5.62 cm), seedling vigour index (1002) and electrical conductivity (0.366 $dSm^{-1)}$ were recorded due to soil application of FYM 50% + vermicompost 50% + biofertilizers.

The soil application of FYM 50%+vermicompost 50%+biofertilizers (5 kg/ha) coupled with foliar spray NAA (10 ppm) found to be superior over control.