EFFECT OF SOIL TEST BASED INM PRACTICES ON THE PERFORMANCE OF CHILLI (*Capsicum annuum* L.)

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C E R T I F I C A T E

This is to certify that the thesis entitled **"EFFECT OF SOIL TEST BASED INM PRACTICES ON THE PERFORMANCE OF CHILLI (*Capsicum annuum* L.)"** submitted in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (HORTICULTURE)** in **VEGETABLE SCIENCE** to the University of Horticultural Sciences, Bagalkot, is a record of research work carried out by **RANJITHA B. M.** under my guidance and supervision and that no part of the thesis has been submitted for the award of any degree, diploma, associateship, fellowship or other similar titles.

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Bagalkot

July, 2016 *(Ranjitha B. M.)*


AFFECTIONATELY DEDICATED
TO MY BELOVED
PARENTS, BROTHERS AND
MY CHAIRPERSON

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1. INTRODUCTION

Chilli or pepper (*Capsicum annuum* L.) belongs to family Solanaceae. It is one of the most valuable crops of India and cultivated throughout the warm, temperate, tropical and subtropical countries. Chilli was originated in Tropical America. The chillies are unique, being used both as vegetable and spice. The crop is grown largely for its fruits all over the India. It is used in India as a principle ingredient of various curries and chutneys. It is also used as vegetable, spice, condiment and for preparation of sauces and pickles. Dry chillies are used for curry powder. They impart pungency, flavour and colour to foods. They also provide essential vitamins, minerals and nutrients. Chilli extracts are used in pharmaceuticals, cosmetic products, paints and chilli sprays. In addition to use as food, condiment, medicine chillies are also used for their ornamental beauty.

India shares about 25.26 % of chilli production in the world, it occupies an area of 775 (000'ha), production 1492 (000'MT) and productivity is 1.9 MT/ha. In India, Andra Pradesh is the major state occupies an area of 131.32 (000'ha) and production is 601.99 (000'MT) followed by Karnataka which occupies an area of 89.56 (000'ha) and production of 111.55 (000'Mt) followed by Maharashtra (NHB-2014-15).

A large number of constraints limit the production of chilli which include low yielding ability of genetic material, imbalanced supply of nutrients, pest and diseases (leaf curl or murda complex spread by thrips and mites) etc. There is need to optimize these production factors for better yield in chilli. The technologies in the above mentioned aspects especially low cost ones need to be developed so that such technologies are easily accepted and adopted by the farming community.

Chilli is grown with all modern agricultural practices, which include chemical fertilizers and pesticides. Because of continuous use of chemicals in chilli, the crop has been highly vulnerable to large of pest and diseases. Several sucking pests like mites and thrips have made the existence of chilli crop most vulnerable. In view of these problems research priority especially with regard to nutrient management need to be changed. In this regard dependency on chemical fertilizers need to be reduced and as these chemical fertilizers are imported from foreign countries which further

adds more production cost per unit area to farmers. In order to minimize the usage of chemical fertilizers to reduce the burden on expense of nation and to promote environment friendly organic sources of nutrient, it is imperative to switch over to organic amendments which will largely reduce the dependency on chemical fertilizers.

In recent past Horticulture has undergone enormous change due to introduction of new varieties and hybrids, development of new technologies such as use of chemical fertilizers, pesticides, weedicides, growth regulators and other inputs as well as improved agricultural practices like drip irrigation. With the dawn of green revolution during mid 60's farmers were advised to take up intensive agriculture with chemicals, fertilizers, pesticides and new hybrids. As a result of this monoculture systems have been developed across the country, which led to loss of biodiversity and rampant soil degradation. Now, in many parts of the country the farmers have realized the ill effects of indiscriminate use of chemicals and fertilizers not only on the health of soil, but also on the society.

Now the government and policy makers are seriously considering alternative methods to intensive agriculture such as organic farming practices, natural farming, INM, biodynamic practices etc., Adoption of organic farming practice alone may not address the food and nutritional requirement of our country as evident from several cases. Hence the blend of organic farming practices and modern agriculture needs to be developed. In this regard INM practices appear to be most promising technologies which can address the problem faced by the farmers.

The beneficial effects of combined application of chemical fertilizers with organic manures and organic amendments spray are universally known. Application of organic manures in general improves the availability of micronutrients like zinc, iron, manganese and copper. A balanced application of both organic and inorganic fertilizers with organic amendments appears to be an alternative approach to meet nutrient requirements of crop.

There is a need to assess the impact of different nutrient management practices (organic farming, INM and chemical farming) on the performance of chilli hybrid like Sitara. With this background the present investigation was undertaken to study the

"**Effect of soil test based INM practices on the performance of Chilli**" with the following objectives.

1. To assess the impact of different nutrient management practices (organic farming, INM and chemical farming) and organic amendments on the performance of Chilli.

2. To work out the economics of different nutrient management practices and organic amendments on the performance of Chilli.

2. REVIEW OF LITERATURE

In India, the increasing population on a near stabilized agricultural land places a heavy burden on the soil resource particularly its nutrient supplying power. Intensive agriculture involving the use of chemical fertilizers in large amount has, no doubt, resulted in manifold increase in the productivity of farm commodities but, the adverse effects of these chemicals are clearly visible on soil structure, micro flora, quality of water, food and fodder. Integrated nutrient management envisages the comprehensive management approach to improve the soil health, eco-system and the quality of produce. A healthy soil with proper cropping pattern and integrated nutrient management can sustain optimum productivity over the years. However, a living soil can be maintained by continuous incorporation of crop and weed biomass, use of animal dung, urine-based manures *viz.*, FYM, compost *etc.*, along with organic amendments such as jeevamrutha, panchagavya and gomuthra besides achieving higher growth, yield and quality of crops. In this context, the literature pertaining to the integrated nutrient management or nutrition in chilli is reviewed in this chapter under appropriate following headings.

2.1 Effect of chemical fertilizers on the performance of chilli and other vegetables

2.1.1 Growth, yield and quality parameters

Khan and Suryanarayana (1978) studied the effect of N, P and K on the growth of chilli var. N.P.46 A. The results revealed that the highest yield (1440 kg per ha) of chilli cv. 'NP 46 A' was obtained with N at 120 kg per ha + P_2O_5 and K_2O each at 45 kg per ha.

Subbaih *et al.* (1980) reported that, the capsaicin content of the ripe fruits was significantly influenced by NPK. Capsaicin content is reduced by the omission of K. The highest capsaicin content (17.2%) was reported when crop was fed with 80:0:35 NPK. Plants with no additional NPK contained 13.4% capsaicin but the lowest content (10.4%) was with the 0:35:0 and 120:0:0 NPK treatments.

Effect of various levels of nitrogen and phosphorus on growth and yield of chilli (*Capsicum Annuum* L.) was studied by Singh and Srivastava (1988) and they recommended application of N in four splits at 30 days intervals which helped to release maximum yields and profits in chilli production.

Subhani *et al.* (1990) evaluated the effect of graded levels and time of application of N and K_2O on flowering, fruiting and yield of irrigated chilli. The highest yield of chilli obtained when both N and K were applied in four splits at planting, 30, 60 and 90 DAT.

Sharma and Peshin (1996) observed a significant increase in fruit length, number of fruits per plant and fruit yield of chilli with increase in nitrogen levels. The highest was being at 150 kg N per ha. Similarly, significant improvements in yield and yield attributes of chilli due to application of phosphorus (90 kg per ha) reported by many scientists (Narasappa *et al.,* 1985 and Methi *et al.*, 1990).

Balaraja (1999) reported the highest fruit length (13.11 cm) with the application of 150:75:75 kg N, P_2O_5 and K_2O per ha in chilli. Similarly, Jayaraj *et al.* (1999) also recorded a significantly higher chilli fruit yield (5434.00 kg/ha) with the application of 180:40:40 kg N, P_2O_5 and K_2O per ha.

Shashidhara (2000) studied the integrated nutrient management in chilli (*Capsicum annuum* L.) under northern transition zone of Karnataka and found that the application of 100 per cent RDF (100:50:50 kg N: P_2O_5: K_2O per ha) recorded maximum fruit yield of chilli (629.60 kg per ha) as compared to 50 per cent RDF and control (509.33 kg per ha).

Singh *et al.* (1999) reported that the application of higher dose of K_2O resulted in a significant improvement in fruit yield of chilli. Further, they also reported that the combined application of N and K (120:105 kg per ha) resulted in significantly higher fruit length, fruit weight and fruit yield compared to control and individual application of these nutrients.

Hossain *et al.* (2001) conducted an experiment to know effect of nitrogen, phosphorous and potash on growth and yield of chilli cv. Pusa Jwala and found that application of 120 kg N, 30 kg P and 30 kg K per ha resulted in optimum plant height, number of branches per plant, flowering, fruit maturity and number of fruits in chilli.

Malagi (2001) reported that the application of 100 kg N ha to chilli recorded the highest plant height (94.00 cm), number of branches per plant (37.00), leaf area index (0.93), total dry matter production (102.00 g per plant) and its distribution in different plant parts compared to the application of 75, 50 and 25 kg N per ha. A significantly higher uptake of N, P and K was also recorded with the application of 100 kg N per ha over control.

Nirmal kumar *et al.* (2003) studied the response of chilli cv. Balijhuri to different doses of N, P, K, S and Zn. All the nutrients were found beneficial in enhancing number of fruits per plant, fresh yield as well as dry yield. Number of fruits per plant, fresh yield as well as dry yield of chilli were markedly increased with the increase of N, P, K, S and Zn upto a certain doses.

Santoshkumar and Shashidhara (2006) reported that application of 100 per cent RDF @ 100:50:50 kg N: P_2O_5: K_2O per ha recorded maximum 100 fruit weight (86.30 g) and yield (702.00 kg per ha) of chilli genotype Byadagi dabbi besides recording higher uptake of N, P and K (36.30, 5.10 and 27.20) kg per ha, respectively.

Datir *et al.* (2012) conducted a trial on ‘‘Application of amino acid chelated micronutrients for enhancing growth and productivity in chilli (*Capsicum annuum* L.)’’ in Nasik district during 2009 and 2010. The plant height was more due to 1.5 % Amino acid micronutrients chelate solution. Number of branches per plant, leaf area per plant, fruits per plant, fruit length, fresh fruit weight and total yield per plant was more due to 2 % amino acid micronutrients chelate solution.

Bhuvaneshwari *et al.* (2013), reported the combined effect of nitrogen and potassium, and the maximum plant height and number of fruit per plant were highest in treatment containing 75 kg per ha N + 60 kg per ha K.

Khan *et al.* (2014) studied on the influence of nitrogen and potassium levels on growth and yield of chillies. The result indicated that nitrogen @ 180 kg per ha and potassium @ 50 kg per ha had positive effect on growth and quality parameters.

2.1.2 Soil properties

Anand and Yaduvanshi (2000) reported that the soil organic carbon, available Zn and Mn were significantly lower in treatments consisting of inorganic fertilizers compared to those treatments involving organics with fertilizers.

The significantly highest uptake of nitrogen (86.33 kg/ha) phosphorus (43.17 kg/ha) and potassium (51.20 kg/ha) was recorded when crop was nourished with 100% RDN through urea in split doses and entire dose of P_2O_5 and K_2O added at transplanting. However the lowest uptake of nitrogen (63.91 kg/ha), phosphorus (28.50 kg/ha) and potassium (39.85 kg/ha) was recorded in those plants which were fed with 75% RDN through green manure + 25% RDN through urea (Medhe *et al.* 2010).

2.2 Effect of organic source of nutrients on the performance of chilli and other vegetables

2.2.1 Growth, yield and quality parameters

In sweet potato, Ravindran and Balanambisan (1987) reported that the starch content of sweet potato increased with the increased rate of application of organics *viz.*, FYM @ 5 t per ha (72.50 %) and FYM @ 10 t per ha (75 %).

Pither and Hall (1990) found a higher content of vitamin C, vitamin A and potassium in organically grown tomato over conventionally grown tomato. Likewise, highest number of fruits per plant, fruit weight, fruit length and fruit diameter of chilli was obtained by applying vermi compost alone as compared to inorganic fertilizers (Yadav and Vijayakumari, 2003).

Thimma Naik (2006) conducted an experiment to study the effect of organic manures on growth, yield and quality of chilli under northern transition zone of Karnataka during *kharif* 2005-06 at MARS, University of Agricultural Sciences, Dharwad. The quality parameters like oleoresin per cent increased by 13.89, 6.60, 3.70 and 2.30 per cent with application poultry manure @ 7.50 t per ha, vermi compost @ 10 t per ha, FYM (50 %) + vermi compost (50 %), FYM (50 %) + neem cake (50 %), respectively over RDF alone. The extractable colour value also increased by 2.90 to 6.00 per cent with application of FYM (50 %) + poultry manure (50 %), FYM (50 %) + neem cake (50 %) over RDF alone.

Naveen *et al.* (2009) analyzed qualitative parameters of green chillies like ascorbic acid, capsaicin, oleoresin and moisture content etc and 100 % organic

manure (composted coir pith 25% + vermi compost 25% + bio-digested slurry 25% + *Azospirillum*-PSB 25%) gave better results compare to all other treatments for quality parameters.

Deore *et al.* (2010) revealed that, 3% novel organic liquid fertilizer application resulted in maximum plant height, number of branches per plant, leaf number, leaf area, fresh and dry weight of the plant, number of fruits per plant and total yield.

Yelmane *et al.* (2010) The extracts of different organics of neem cake, mustard cake, FYM, groundnut cake, poultry manure, press mud, castor cake and coconut cake were tested against *F. solani* by poisoned food technique in *in vitro*. Least growth of the pathogen was recorded in the extracts of neem cake showing excellent inhibitory effect *i.e* 59.8% against *F. solani*. Next best in order of merit was mustard cake (52.61%) followed by FYM (49.40%), groundnut cake (44.80%), poultry manure (42.29%), and least by other cakes.

Application of green manure (sun hemp) + neem cake @ 2 t per ha + *Azospirillum* @ 2 kg per ha + burnt ash (crop residue) + phosphobacteria recorded higher growth parameters like plant height, plant spread, number of branches per plant of chilli over RDF alone (Bharathi *et al.*, 2011).

Patil *et al.* (2014) studied the effect of organic nutrient and biological pest management practices on insect pests and disease dynamics in organic chilli production system. The result revealed that yield of dry chilli was highest with the application of organic manures. Similar results were noticed in tomato by Rajbir and Ram (2005).

Monika rana *et al.* (2015) revealed that panchagavya along with organic manures showed significantly enhanced microbial population and crop growth in legumes and different cropping system.

Patel *et al.* (2015) studied on organic cultivation of chilli and compared the organic cultivation with conventional one and with respect to all the growth and quality traits the organic cultivation was proved to be the best.

2.2.2 Soil properties

Anand and Yaduvanshi (2000) reported that the soil organic carbon, available Zn and Mn were significantly lower in treatments receiving inorganic fertilizers compared to the treatments involving organics with fertilizers.

Tolanur and Badanur (2003) reported that there was no change in pH of soil due to the application of 100 per cent RDF through inorganics and 50 per cent RDF through inorganics + 50 per cent RDF through FYM. But, they noticed a change in EC and increase in organic carbon (0.47 %) content of soil with the application of 50 per cent RDF through FYM and 50 per cent RDF through fertilizer compared to 100 per cent RDF through inorganics alone (0.44 %).

Hangarge *et al.* (2004) conducted a field experiment to study the influence of vermi compost and other organics on fertility and productivity of soil under chilli spinach cropping system. Application of liquid organics such as organic booster @ 1 L/m^2, cow dung urine slurry @ 1 L/m^2 along with vermi compost @ 5 t per ha recorded higher organic carbon content than the RDF. whereas, the pH and EC were decreased after harvest of chilli compared to initial values. The higher organic carbon of 1.23 per cent and the lower pH and EC values 7.87 and 0.73 dS/m respectively, against the initial values of 8.35 and 0.79 dS/m were obtained with the combined application of vermi compost @ 5 t/ha + cow dung urine slurry @ 1 L /m^2

Shwetha and Babalad (2008) reported that the combined application of fermented organics *viz.,* beejamrut, jeevamrutha, and panchagavya along with organics such as compost, vermi compost, and green leaf manure recorded the higher soil biological activity. Similarly, dehydrogenase activity was higher with combined application of organics and fermented organics than their individual applications. The highest dehydrogenase activity of 34.84 µg TPF/g soil/day was observed with compost + vermi compost + green leaf manure + Jeevamrutha + Beejamrut and was on par with the treatment receiving vermi compost + green leaf manure + Jeevamrutha + Beejamrut + Panchagavya. The lowest dehydrogenase activity of 24.27 µg TPF/g soil/day was noticed with the application of RDF + FYM at 60 DAS of soybean in soybean-wheat cropping system.

Naveen *et al.* (2009) confirmed that nutrient supplemented with 100% organic manures (Composted coir pith 25% + Vermi compost 25% + Biodigested slurry 25% + Azospirillum-PSB 25%) recorded higher population of bacteria, fungi and actinomycetes in chilli cropping system after harvest of the crop.

2.3 Effect of INM on the performance of chilli and other vegetables

2.3.1 Growth, yield and quality parameters

De and Laloraya (1980) observed the seedlings of the capsicum cv. Jwala were raised on soil fertilized with ammonium sulphate, urea, green manure (unspecified) poultry manure or FYM and it was concluded that, vitamins B1, C and E was highest in seedlings receiving ammonium sulphate.

Amirthalingam (1988) studied the effect of *Azospirillum*, nitrogen and NAA on growth and yield of chilli (Capsicum annuum) and noticed that inoculation of *Azospirillum* to seed, soil and seedling increased the plant height, number of branches, length of tap root and root spread, induced earliness in the first flower appearance and 50 per cent flowering. The same treatment increased the number of flowers, number of fruits per plant, fresh and dry weight of fruit/plant, length and girth of fruit, number of seeds and weight of seeds/fruit. The dry matter production was increased due to the inoculation of *Azospirillum* to seed, soil and seedling. The same treatment also recorded the highest ascorbic acid content and capsaicin content. Inoculation of *Azospirillum* also enhanced the nitrogen and phosphorus content of the plant. The yield obtained with the inoculation of *Azospirillum* to seed, soil and seedling at 75 per cent fertilizer N was on par with the yield obtained by 100 per cent N without inoculation.

Meena Nair and Peter (1990) reported that, N at 125 or 175 kg per ha along with FYM significantly increased the yield compared with the organic or inorganic fertilizers applied alone. The number and weight of unmarketable fruits recorded after 10 days of storage increased with increasing rates of FYM and fertilizers.

Hosmani (1993) also reported higher yields of chilli with integrated use of chemical and organic fertilizers than with the use of either of these separately.

Subbiah (1994) evaluated the effect of N, P and Azospirillum on yield and nutrient uptake in chilli and bellary onion and observed that application of *Azospirillum* in combination with 75 per cent as well as at 100 per cent of the recommended doses of N and P provided higher yield of chilli than the yield in chilli obtained from the plot which received 100 per cent of the recommended doses of N and P. At 100 per cent of recommended dose with inoculation had given the highest total dry yield. N and P contents in chilli fruits and P content in plants were significantly influenced by the N, P and biofertilizers.

Deka *et al.* (1996) studied the effect of *Azospirillum* and chemical fertilizers on growth and yield of chilli cv. Pusa Jwala and revealed that the treatment 70kg N/ha + *Azospirillum* gave more number of branches per plant (13.2), highest average yield (136.9q/ha) than control and 70kg N/ha alone.

Shashidhara (2000) found that the combined application of both organics and inorganics significantly increased the ascorbic acid in chilli compared to 100 per cent RDF alone.

Hangarge *et al.* (2001) revealed that the application of vermi compost in combination with chemical fertilizers significantly increased growth attributes of chilli compared to organic manure and chemical fertilizers alone.

Patil and Biradar (2001) conducted a experimental trial on effect of foliar application of essential nutrients on chillies and recorded the highest fruit yield (19.12 q per ha) due to the application of 200 per cent RDF + FYM (10 t per ha) + Vermi compost (2.5 t per ha).

Sharu and Meerabai (2001) studied the effect of integrated nutrient management on yield and quality in chilli (*Capsicum annuum* L.). Among 13 treatments 100%N as poultry manure was found to be the best for high keeping quality. 75% N as poultry manure + 25 % N as chemical fertilizer was having high vitamin C. Poultry manure proved to be the best and among various combinations (1:1 ratio of chemical fertilizer and organic manure) found to be the best for increasing the yield and quality of chilli.

Patil *et al.* (2004) conducted an experiment to study the effect of organic and inorganic fertilizers on growth, yield and quality of tomato at Marathwada Agricultural University, Parbhani during 2000-2001. Application of FYM (50 %) along with half RDF recorded maximum number of fruits per plant and the highest fruit yield, fruit juice, TSS and ascorbic acid content over 100 per cent RDF.

In Tomato, Poul *et al.* (2004) reported that application of half RDF through inorganics + half RDF through FYM + zatpatkhat recorded higher uptake of N (1.62 g per plant), P (0.12 g per plant) and K (1.14 g per plant) than RDF (0.76, 0.04 and 0.51 g per plant N, P and K, respectively).

Santoshkumar and Shashidhara (2006) reported from their study on integrated nutrient management in chilli genotypes that the application of FYM @ 10 t per ha along with RDF increased oleoresin content and quality parameters over 100 per cent RDF alone.

Gopinath *et al.* (2008) reported that, the number of fruits per plant and fruit yield was significantly higher under INM compared with organic nutrient supply. Among the bell pepper varieties, 'US Agri 181' produced significantly higher fruit yield compared with other varieties. The soil pH, organic carbon, and microbial activities in terms of urease, dehydrogenase and alkaline phosphatase were higher in the plots treated with organic manures alone compared to INM. The latter, however, recorded higher N, P, and K contents in soil.

Application of glyricidia loppings @ 10 t per ha, crop residues @ 10 t per ha along with FYM + organic solutions significantly increased the growth parameters of chilli compared to inorganic fertilizers (Yadahalli, 2008).

Dorji *et al.* (2009) studied the effect of different levels of NPK and FYM at four levels. Yield per plant significantly increased as the concentration varies. The weight and the number of fruits per plant also were higher with higher rates of NPK and FYM.

Kattimani *et al.* (2009) showed application of organics viz., farm yard manure (FYM) along with 100 per cent recommended dose of fertilizer (RDF) resulted in higher (16 per cent) fruit yield (919 kg per ha) than RDF. Further application of FYM

@ 10 t per ha along with 100 per cent RDF enhanced the uptake of nutrients like N, P and K by 14.1, 44.9 and 37.4 per cent, respectively over RDF.

Surya kumari *et al.* (2009) reported that, integrated use of vermi compost @ 5 t per ha + 150 % RDN showed the maximum plant height, plant spread, number of fruits per plant, days to 50 % flowering, weight of 100 fruits, fruit set and yield per ha.

Talukder and Jana (2009) reported dual inoculation with the biological nitrogen fixers (*Azotobacter and Azospirillum*), 100% recommended dose of N-fertilizer @ 80 kg N per ha and farmyard manure @ 15 t per ha recorded maximum growth, yield (7.43tonnes per ha) and quality parameters, and cost: benefit ratio of 1.55. No significant difference was observed when N-fertilizer level was reduced to 75%. Thus associative nature of the above biofertilizers helped to save 25% nitrogenous fertilizer in chilli crop. There was increased content in plant nitrogen (84.10 mg per kg), phosphate (84.42 mg per kg) and potash (57.46 mg per kg), leaf chlorophyll (0.204 mg per 100 g) and residual available soil nitrogen (202.90 kg per ha), phosphate (67.10 kg per ha) and potash (70.50 kg per ha) with dual inoculation with the biological nitrogen fixers along with full dose of N-fertilizer.

Deshpande *et al.* (2010) investigated on effect of organic and inorganic manures on growth and yield of chilli and reveled that application of nitrogen 125 kg per ha + FYM @ 10 t per ha + *Azospirillum* reported more plant height, number of branches per plant, days to first 50 % flowering, days to first harvest, number of fruits per plant, weight of individual fruit, fruit length and diameter, yield of wet red fruits

In another experiment of INM, application of 100% RDN through urea, (50% at time of transplanting and 50% one month after transplanting) and full recommended dose of P_2O_5 and K_2O at the time of transplanting recorded significantly the highest values regarding plant height (80.73 cm), east-west and north-south plant spread as (53.33 and 52.26 cm), respectively, mean number of primary branches (7.33), leaf area (5.83 dm^2), number of fruits (168.26) per plant, fruit girth (1.06 cm), fruit length (8.60 cm), maximum ascorbic acid content (66.52 mg/100 g) and yield (7958.0 kg.) per hectare (Medhe *et al.* 2010).

Malik *et al.* (2011) growth, yield and fruit quality of sweet pepper hybrid SH-SP-5 was affected by integration of inorganic fertilizers and organic manures and nitrogen @ 150 kg per ha, phosphorous @ 120 kg per ha potassium @ 60 kg per ha and FYM @ 40 t per ha proved better to improve the growth and enhance yield attributing traits.

Khan *et al.* (2012) revealed that, cultivar Pusa Jwala showed significantly higher growth, yield and quality parameters with the inoculation of biological nitrogen fixers like *Azospirrilum* and *Azatobactor*. Simultaneous inoculation with biofertilizers (100% recommended dose of N-fertiliser 100 kg N per ha and farmyard manure 15 t per ha) resulted the maximum growth, yield, and quality parameters. The associative nature of the above biofertilizers helps to save 25% nitrogenous fertilizer in chilli crop. There was increased content in plant nitrogen, phosphate and potash, leaf chlorophyll and residual available soil nitrogen, phosphate and potash with dual inoculation with the biological nitrogen fixers along with recommended full dose of nitrogen fertilizer.

Vimera *et al.* (2012) studied on integrated nutrient management strategies for quality production of King Chilli. Among 12 treatments yield was more due to 50% NPK + 50% FYM + biofertilizers, 50% NPK + 50% pig manure + biofertilizers, 50% NPK + 50% vermi compost + biofertilizers and maximum available N (305 kg per ha) content after harvest was observed under 100% NPK (90:60:60 kg per ha).

Pariari and Khan (2013) studied the different combinations of organic manures and inorganic fertilizers. Among different combinations, vermi compost along with 50% Urea recorded maximum plant height, number of branches per plant. Qualitative aspects were increased with the application of neemcake compare to inorganic sources.

Samsangheile and Kanaujia (2014) conducted an experiment on effect of integrated nutrient management on growth, yield and quality of chilli (Capsicum annuum L.) and fertility status of soil under foothill condition of Nagaland. Among 12 different treatments 50% NPK + 50% FYM + bio fertilizers showed more nutrient status of soil after harvesting of crop. N, P, K and organic carbon content were more

compare to all other treatments. Apart from this the pH of soil was 4.9 where all other treatments showing less pH than this, so by this one can conclude that FYM and bio fertilizers are having positive effect on soil health.

Leela rani *et al.* (2015) confirmed that, combined application of 150 kg N per ha along with 10t FYM and 0.5 t neem cake per ha had significantly increased the plant height, canopy spread, number of branches per plant, number of fruits per plant, yield per plant and total green chilli yield.

In Paprika, Shiva *et al.* (2015) revealed that application of vermi compost (250 g per plant) combined with neem cake (100 g per plant) recorded higher growth parameters, yield and quality attributes, which was comparable with inorganic fertilizers at the recommended levels. Under integrated nutrient management, application of 75% N (8 g per plant) + *Azospirillum spp*. (5 g per plant) + 75% P (1.7 g per plant) + Phosphobacteria (5 g per plant) + 100% K (2.5 g per plant) improved the growth, yield and quality parameters of paprika alike chillies as compared to recommended NPK through fertilizers indicating a saving 25% of both inorganic N and P through biofertilizers.

Vikash kumar *et al.* (2016) conducted experiment on effect of INM practices on plant growth, fruit yield and yield attributes in chilli and reported that application of 25 t FYM per ha along with RDF (100:50:50 NPK kg per ha) recorded higher plant height. Similar trend was also noticed with respect to days to 50% flowering, higher number of fruits, fruit length, fruit diameter, seed weight over control.

2.3.2 Soil properties

Nanthakumar and Veeragavathatham (2001) studied the effect of integrated nutrient management on the nutrient content of brinjal variety Palur-1. They found that nitrogen, phosphorous and potassium contents were highest in the treatments involving organic manure + inorganic fertilizers + biofertilizers.

Choudhary *et al.* (2005) studied the effects of integrated use of organic manure, biofertilizers and chemical fertilizers on nutrient status of soil and yield of brinjal. Soil available nitrogen, phosphorous and potassium increased significantly with the application of various organic and microbial sources of nutrients in

combination with fertilizers over control. The organic carbon and available nitrogen status were increased significantly with conjunctive use of inorganic fertilizers, biofertilizers and farm yard manure.

Dass *et al.* (2008) conducted an experiment with seven treatments including chemical fertilizers, vermi compost (VC), cow manure (CM), and microbial inoculants (*Azotobacter* and Phosphate Solubilizing Bacteria) for three consecutive years (2001 to 2003), at Koraput, India to determine the most effective integrated nutrient management for production, economics, and soil improvement in cabbage and bell pepper. They reported that bulk density of the surface soil after three years was reduced; its organic carbon and available nitrogen and phosphorous status improved due to treatment with cow dung manure and vermi compost. The data indicated that application of 5 t/ha of vermi compost can meet 50% of the fertilizer requirement of both crops while ensuring higher productivity, income, and residual soil fertility.

Sharma *et al.* (2008) conducted investigation to study the response of broccoli to integrated nutrient management using organic manure and *Azotobacter* along with the synthetic fertilizers and concluded that an application of 100% NPK + *Azotobacter* + 20t/ha cow manure resulted in the highest increase in the contents of organic carbon and available nitrogen, phosphorous and potassium by 36, 32 and 19%, respectively, over their initial status in the soil. About 31, 8.4 and 12.5 kg/ha of nitrogen, phosphorous and potassium, respectively can be saved in broccoli production if cow manure at 20t/ha and *Azotobacter* are used in combination with synthetic fertilizers.

Sharma *et al.* (2009) conducted an experiment to study the influence of biofertilizers alone or in combination with chemical fertilizers in cauliflower nutrient uptake and residual soil fertility and concluded that the highest nitrogen, phosphorous and potassium uptake was recorded with combined inoculation of *Azotobacter* and Phosphorous Solubilizing Bacteria. The maximum soil fertility build up was observed in treatment combination of bio-inoculants integrated with recommended dose of nitrogen, phosphorous and potassium, which was to the tune of about 17.10 and 15.00 kg NPK/ha over the initial soil status.

2.4 Effect of Organic amendments on the performance of chilli and other vegetables

Panchagavya, a liquid organic amendment is a 30 days fermented stock solution of cow dung (7kg), cow ghee (1kg), cow urine (10 litres), water (10 litres), cow milk (3 litres), cow curd (2 litres), tender coconut water (3 litres), jaggery (3 kg), well ripened Poovan banana (12 nos.), having approximate chemical composition of pH- 5.45, EC- 10.22 dS/m, total N – 229.00 ppm, total P-209.00 ppm, total K – 232.00 ppm, Sodium – 90.00 ppm, Calcium – 25.00 ppm, IAA – 8.50 ppm, GA – 3.50 ppm and with a microbial load of fungi 38800 per ml, bacteria–1880000 per ml, *Lactobacillus*-10000 per ml, total anaerobes–10000 per ml, acid formers–360 per ml and *Methanogen*–250 per ml.

Jeevamrutha is a fermented liquid product prepared by mixing up cow dung (10 kg) with cow urine (10 litres), jaggery (2 kg), legume flour (2 kg) and handful of soil brought from the bunds of the lands where cultivation is to be taken up. Jeevamrutha also contains enormous amount of microbial load which multiply and act as a soil tonic, having approximate chemical composition of pH- 7.07, EC- 3.40 dS/m, total nitrogen – 770 ppm, total phosphorous - 116 ppm, total potassium - 126 ppm, total zinc - 4.29 ppm, total copper - 1.58 ppm, total iron -2.82 ppm, total manganese - 10.7 ppm, bacteria- 20.4 cfu per ml, fungi-13.8 cfu per ml, actinomycetes - 3.6 cfu per ml, phosphate solublising organisms- 4.5 cfu per ml and free living N fixers - 5.0 cfu per ml. It is said to enhance microbial activity in soil and ultimately ensuring the availability and uptake of nutrients by the crops.

Among liquid manures, the combined application of jeevamrutha + panchagavya and beejamrut + jeevamrutha recorded significantly higher dehydrogenease activity over control which might be due to presence of naturally occurring, beneficial microorganisms in Panchagavya that improve soil quality (Xu and Xu, 2000).

At Indian Grassland and Fodder Research Institute, Jhansi research was conducted with various jaivic and vedic krishi inputs such as angara, amritpani, panchagavya and gomuthra *etc.* the results revealed that all the jaivic and vedic krishi inputs improved the crop productivity, soil microbial population and soil biological activity (Sadanandan and Drand, 2006).

Somasundaram and Singaram (2006) analyzed panchagavya to know its composition which was found to contain total N (302.00 mg per kg), total P (218.00 mg per kg), total K (355.00 mg per kg), total sugars (205.00 µg per ml), glucose (6.00 mg per dl), sodium (96.00 mg per kg), calcium (27.00 mg per kg), total organic carbon (0.80 per cent), IAA (9.15 mg per kg), GA (4.00 µg per kg), phenols (0.75 µg per ml) bacteria (34 x 106 cfu per ml), fungi (22 x 104 cfu per ml), *Actinomycetes* (3 x 1012 cfu per ml), *Pseudomonas* (45 x 103 cfu per ml), yeast (35 x 104 cfu per ml), lactic acid bacteria (22 x 106 cfu per ml), methylotrophs (5 x 103 cfu per ml), *Azospirillum* (2 x 102 cfu per ml), *Acetobacter* (43 x 103 cfu per ml), ammonium oxidizers (24 x 105 cfu per ml), nitrite oxidizers (2 x 102 cfu per ml), pH (5.62), EC (10.3 dS per m), Zn (0.26 mg per kg), Fe (0.83 mg per kg), Mn (0.23 mg per kg) and Cu (0.2 mg per kg).

Jeevamrutha contains enormous amount of microbial load which multiplies in the soil and acts as a tonic to enhance microbial activity in soil (Palekar, 2006 and Vasanthkumar, 2006).

Swaminathan *et al.* (2007) in their study on panchagavya reported that panchagavya is a fermented liquid of 5 main ingredients *viz.*, cow dung, cow urine, cow milk, ghee and curd (5.70 kg, 3.46 litres, 2.30 litres, 2.30 litres and 1.15 kg, respectively). Further, they reported that the ultimate product had total N (302.00 g per kg), total P (219.00 mg per kg), total K (355.00 mg per kg), total organic carbon (0.80 per cent), bacteria (34 x 106 cfu per ml), fungi (22 x 104 cfu per ml), *Actinomycetes* (3 x 102 cfu per ml), Zn (0.26 mg per kg), Fe (0.83 mg per kg), Mn (0.23 mg per kg), Cu (0.20mg per kg), pH of 6.02 and electrical conductivity 3.02 dS per m.

Shwetha and Babalad (2008) reported that the combined application of fermented organics *viz.,* beejamrut, jeevamrutha, panchagavya along with organics such as compost, vermi compost and green leaf manure recorded the higher soil biological activity. Similarly, dehydrogenase activity was higher with combined application of organics and fermented organics than their individual applications and RDF + FYM. The highest dehydrogenase activity was observed with compost + vermi

compost + green leaf manure + jeevamrutha + beejamrut and is on par with the treatment consisting vermi compost + green leaf manure + jeevamrutha + beejamrut + panchagavya. The lowest dehydrogenase activity was noticed with the application of RDF + FYM at 60 DAS of soybean in soybean-wheat cropping system.

Kondapanaidu *et al.* (2009) studied the effect of INM practices on yield, nutrient uptake and quality of chilli (Cv. Byadgi dabbi) in a vertisol. Among 10 treatments, 50% RDN + 50% N through FYM + BF + panchagavya was found best for higher dry chilli yield, total dry matter production, number of fruits per plant per picking, maximum ascorbic acid content in green fruits, maximum colour value in red fruits.

Dipping the chilli seedlings root in beejamruth, soil application of jeevamrutha (500 litre per ha) at 10 DAT and foliar application of panchagavya @ 3% at the time of flowering recorded higher ascorbic acid and capsaicin content in chilli fruits (Sreenivasa *et al.,* 2010).

Nileema and Sreenivasa (2011) studied the influence of liquid organic manures on growth, nutrient content and yield of tomato and reported that panchagavya and jeevamrutha has possess nutrients like N, P, K, Zn, Cu, Fe, Mn and also beneficial microbes in them.

Prashith *et al.* (2014) reported the antifungal effect of cow urine on anthracnose of chilli.

Rao *et al.* (2014) observed beneficial effect of panchagavya in combination with vermi compost as exhibited enhanced in the growth parameters like height of plant, number of branches, number of fruits and size of fruits as compared to the plants which were nourished with vermi compost alone.

Ponnumani and Semmalar (2015) studied the effect of panchagavya on growth and performance of *Capsicum frutescence.* The concentration of the panchagavya was gradually increased from 25%, 50%, 75% and 100%. The plant growth, leaf length, leaf weight, root length and chlorophyll content were showing gradual positive response as the concentration of panchagavya increases.

2.5 Economics of different nutrient management practices

Deka *et al.* (1996) worked out the comparative economics in chilli cv. Pusa Jwala the treatment with 70kg N/ha + *Azospirillum* was the most profitable, which earned a net profit of Rs. 59,335/ha with a benefit cost ratio of 6:1 as against 4.8:1 in 70 kg N/ha alone.

In potato, Sesani *et al.* (2003) reported higher cost of cultivation (Rs.16624 per ha), gross income (Rs.122970 per ha) and net income (Rs.56346 per ha) with the application of RDF + FYM @ 25 t per ha over RDF (Rs.6624 per ha, Rs.112230 per ha, Rs.55606 per ha cost of cultivation, gross income and net income, respectively). Similarly, Santoshkumar and Shashidhara (2006) also observed higher net returns with combined application of organics and inorganics over inorganics alone in chilli.

Dorji *et al.* (2009) studied the effect of different levels of NPK and FYM. Yield per plant significantly increased as the concentration varies. By economic analysis the marginal rate of returns (MRR = the profit for every additional one unit) were greater when applying 2t of FYM along with NPK of 8-6-6 kg per ac, 16-8-8 kg per ac and 24-18-18 kg per ac. Applying 4 and 8t of FYM along with three doses of NPK was not economical.

Gopinath *et al.* (2008) reported among the bell pepper varieties, ‘US Agri 181’ was the best variety as it yielded highest followed by ‘Aishwarya’. Same US Agri 181 variety showed high benefit cost ratio of 9.2 compared to Aishwarya and California wonder.

Shwetha and Babalad (2008) reported that the net return in soybean was significantly higher with combined application of organic and fermented liquid manures over no fermented liquid manures. Similarly, Yadav and Christopher (2006) reported significantly higher net returns with panchagavya spray over no panchagavya spray. However, B: C ratio was also higher with combined application of RDF and panchagavya (2.28) over RDN through organics + panchagavya spray in rice.

Kondapanaidu *et al.* (2009) studied the effect of INM on yield, nutrient uptake and quality of chilli (Cv. Byadgi dabbi) in a vertisol. Among 10 treatments application of 50% RDN + 50% N through FYM + BF + panchagavya showed highest B: C ratio (1.78).

Talukder and Jana (2009) reported dual inoculation with the biological nitrogen fixers (*Azotobacter* and *Azospirillum),* 100% recommended dose of N-fertilizer @ 80 kg N per ha and farmyard manure @ 15 tonnes per ha recorded maximum growth, yield (7.43tonnes per ha) and higher cost: benefit ratio of 1.55 and there was no significant difference when N-fertilizer level was reduced to 75%.

Medhe *et al.* (2010) reported that application of 100% RDN through urea, (50% at time of transplanting and 50% one month after transplanting) and full recommended dose of P_2O_5 and K_2O at the time of transplanting, showed maximum benefit: cost ratio of 4.68:1.

Shivaprasad (2010) studied on yield and economics of chilli (Cv. Bydagi dabbi) as influenced by integrated nutrient management. Worked out the benefit cost ratio and obtained highest with the application of 10t FYM and benefit cost ratio was 2.53.

Naik (2012) concluded that the benefit cost ratio was 1.83 for organic chilli cultivation and that of inorganic chilli was 1.35. Similarly, Patel *et al.* (2015) also reported higher benefit cost ratio with organic cultivation *i.e.,* 4.7:1 compared to non conventional practice where benefit cost ratio was 3.48:1.

Vimera *et al.* (2012) conducted studies on integrated nutrient management for quality production of King Chilli. Among different treatments, yield was more in the treatment supplied with 50% NPK + 50% FYM + biofertilizers. But the most profitable treatment was 50% NPK + 50% pig manure + biofertilizers with B: C of 6.19:1 and highest net return of Rs. 571 thousand.

Leela Rani *et al.* (2015) evaluated the integrated nutrient management practices on growth, yield and economics of green chilli cv. Pusa Jwala and reported that higher benefit cost ratio of 2.5:1 and net income due to the application of 150Kg per ha nitrogen along with 10t FYM and 0.5 t neem cake.

3. MATERIAL AND METHODS

The present experiment on **"Effect of soil test based INM practices on the performance of Chilli"** was carried out during 2015-16 at farmer field (Omanna), Neeralakatti village of Dharwad district. Details of the material used and methods adopted for the study are presented in this chapter.

3.1 Experimental site

The experiment on Effect of soil test based INM practices on the performance of Chilli was conducted at farmer field (Omanna), Neeralakatti village of Dharwad during *kharif* 2015-16. The soil chemical properties are presented in Appendix I.

3.2 Meteorological data

Weather parameters prevailed during the cropping period were recorded and presented in Appendix II. The total rainfall fall of 527.00 mm was received during crop growth period from August – 2015 to January - 2016. Mean relative humidity was 80.00 per cent. The mean maximum temperature was 30.09 ^{0}C while the mean minimum temperature was 18.14 ^{0}C.

3.3 Details of experiment

Location	: Dharwad
Crop	: Chilli
Hybrid	: Sitara
Season	: *Kharif* 2015
Experiment design	: 3 x 4 Factorial Randomized Block Design
Plot size	: 4.5 m X 2.4 m
No. of treatment combination	: 3 X 4 = 12
Number of replications	: 3
Spacing	: 90 X 60 cm
Date of transplanting	: 31st August 2015
RDF	: 150: 75: 75 kg N: P: K per ha
RDFYM	: 25 t per ha

Plate 1. General view of experimental plot

3.3.1 Soil type

The soil of experimental site comprised of red soil. A composite soil sample was drawn from experimental area to a depth of 0-30 cm and analyzed for chemical properties.

3.3.2 Experimental design

Factorial Randomized Block Design was adopted with three main plot treatments and four sub plot treatments with three replications.

Treatment details

Factor I: Nutrient management practices.

1. M_1 - Organic practice (supplementation of RDN through organic source)
2. M_2 - INM practices (50 % organic + 50 % inorganic)
3. M_3 - Inorganic practice

Factor II: Organic amendments

1) S_1 - Panchagavya spray @ 3% + *Verticillium luccani* @ 5% at 30 and 60 DAT
2) S_2 - Cow urine spray @ 10% + *Verticillium luccani* @ 5% at 30 and 60 DAT
3) S_3 - Jeevamrutha spray as it is + *Verticillium luccani* @ 5% at 30 and 60 DAT
4) S_4 - Control (water spray)

Treatment combinations

M_1S_1	M_1S_2	M_1S_3	M_1S_4
M_2S_1	M_2S_2	M_2S_3	M_2S_4
M_3S_1	M_3S_2	M_3S_3	M_3S_4

3.3.3 Experimental lay out

The lay out of the experiment is furnished below.

Replication I	Replication II	Replication III
$M_1 S_1$	$M_3 S_4$	$M_2 S_2$
$M_1 S_2$	$M_3 S_1$	$M_2 S_3$
$M_1 S_3$	$M_3 S_2$	$M_2 S_4$
$M_1 S_4$	$M_3 S_3$	$M_2 S_1$
$M_2 S_1$	$M_1 S_2$	$M_3 S_3$
$M_2 S_2$	$M_1 S_3$	$M_3 S_4$
$M_2 S_3$	$M_1 S_4$	$M_3 S_1$
$M_2 S_4$	$M_1 S_1$	$M_3 S_2$
$M_3 S_1$	$M_2 S_2$	$M_1 S_3$
$M_3 S_2$	$M_2 S_3$	$M_1 S_4$
$M_3 S_3$	$M_2 S_4$	$M_1 S_1$
$M_3 S_4$	$M_2 S_1$	$M_1 S_2$

Fig. 1. Lay out of the experiment

3.3.4 Cultivation

3.3.4.1 Preparation of main field and transplanting

The experimental field was brought to a fine tilth by ploughing and harrowing twice each. 30 days old seedlings were used for transplanting. Seedlings were planted in the main field by following inter row distance of 90 cms and intra row distance of 60 cms. According to the treatment need manures and fertilizers were incorporated.

3.3.4.2 Panchagavya preparation

Fresh cow dung (7 kg) and ghee (1 kg) were mixed together and kept in a plastic bucket for two days. The mixture was stirred daily once. On the third day, three litres of cow urine, ten litres of water were added and fermented for 12 days. Then, two litres of curd, two litres of milk, 100 g of yeast, two litres of coconut water, 250 g jaggery and 12 ripe bananas were added and contents were stirred for 15 days thoroughly thrice a day. Afterwards, filtered through a cotton cloth and was used for foliar spray @ 3 per cent.

3.3.4.3 Jeevamrutha preparation

The ingredients *viz.,* cowdung -10 kg, jaggery-2 kg, legume fluor-2 kg, cow urine-10l, soil-hand full were put into a drum containing 200 litres water. After covering the drum with lid, it was kept in shade and stirred thrice a day. After a week, the jeevamrutha will be ready for application.

Note: State Department of Horticulture, Karnataka method was followed for preparation of panchagavya and jeevamrutha.

3.3.4.4 Imposition of treatments and fertilizer application

The fertilizers were added as per treatment details. A calculated quantity of FYM was added to meet the nitrogen requirement for M_1 treatment. Urea, DAP, MOP and FYM were calculated and applied to meet the nutrient requirement of M_2 treatment and finally, for M_3 calculated quantities of Urea, DAP and MOP were applied as per the treatment details.

Spray of organic amendments like panchagavya @ 3 %, cow urine @ 10 %, jeevamrutha as it is and water spray as control were imposed with factor I and two sprays were taken at 30 and 60 DAT along with *Verticillium luccani* @ 5 %.

3.4 Recording of observations

Five plants were tagged at random in each treatment plot and observations were recorded on growth, yield and quality parameters.

3.4.1 Growth/Vegetative parameters

3.4.1.1 Plant height (cm)

The height of the plants from the ground level to the top most leaf was recorded at 30, 60 and 90 DAT and expressed in centimeter.

3.4.1.2 Number of primary branches per plant

Number of primary branches arising from the main stem was recorded from five tagged plants at 30, 60 and 90 days after transplanting (DAT).

3.4.1.3 Number of secondary branches per plant

Number of secondary branches arising from the primary branches was recorded from five tagged plants counted at 30, 60 and 90 days after transplanting (DAT).

3.4.1.4 Stem thickness (cm)

Average stem thickness was measured with the help of Vernier caliper at 30, 60 and 90 days after transplanting (DAT) and expressed in centimeters.

3.4.1.5. Leaf area index

Leaf area index was calculated by graph method

$$LAI = \frac{\text{Leaf area per plant (cm}^2\text{)}}{\text{Land area occupied by the plant (cm}^2\text{)}}$$

3.4.2 Earliness parameters

3.4.2.1 Days to first flowering

Days were counted from the date of transplanting to appearance of the first flower in each treatment plot and recorded as number of days taken for first flowering.

3.4.2.2 Days to 50 per cent flowering

Number of days taken from transplanting to the appearance of flowers in 50 per cent of plants in each experimental plot was recorded as days to 50 per cent flowering

3.4.3 Yield parameters

3.4.3.1 Number of flowers per cluster

Two clusters per plant were taken at random for five tagged plants and numbers of flowers in each cluster were counted. Then, the average number of flowers per cluster was calculated (the clusters selected were tagged for counting the fruits).

3.4.3.2 Number of fruits per cluster

From the tagged clusters total numbers of fruits set per cluster were counted and the average number of fruits per cluster was worked out.

3.4.3.3 Number of flower per plant

Number of flowers were counted at every harvest and added to get total flowers per plant.

3.4.2.4 Number of fruit per plant

Number of green mature fruits harvested from five tagged plants at each picking (harvest) was recorded and average of five plants were worked out

3.4.2.5 Percent fruit set (%)

The per cent fruit set was calculated by using the following formula.

$$\text{Per cent fruit set} = \frac{\text{Number of fruits}}{\text{Number of flowers}} \times 100$$

3.4.2.6 Average fruit weight (g)

Randomly five fruits from each plant were selected and the average of five fruits weight was recorded as average fruit weight and expressed in grams.

3.4.2.7 Yield per plant (g)

Fruit yield per plant was computed by adding the fruit weight of all the pickings and divided by number of plants and expressed in kilo grams per plant.

3.4.2.8 Yield per plot (kg)

The weight of fruits harvested from each picking was recorded from each plot (including the tagged plants) and total yield per plot was estimated by adding the yields of all the harvest expressed in kilograms per plot.

3.4.2.9 Yield (t)

Fruits harvested in each plot from all pickings were measured in kilograms. Yield per hectare was calculated by using following formula and expressed in tonnes per hectare.

$$\text{Yield per hectare (t)} = \frac{\text{Yield per plot (kg)}}{\text{Plot area}} \times \frac{10000}{1000}$$

3.4.2.10 Dry matter content of the plant (%)

After recording fresh weight, the plants were kept in hot air oven at 60 to 70 ^{0}C upto getting constant weight and later dry weight was expressed in percentage.

3.4.3 Quality parameters

3.4.3.1 Ascorbic acid content (mg/100 g)

Samples of the mature green fruits were analyzed for their ascorbic acid content using 2, 6-dichlorophenol visual method (Thimmaiah, 1999). The green fruits were cut into two to three mm pieces and two gram sample was blended with 0.4 per cent oxalic acid and filtered through muslin cloth. To an aliquot of the extract (2 ml) of the sample, 3 ml acid mixture was added and titrated against the standard dye; the end point is the appearance of pink colour (V2). Similar procedure was followed against acid mixture to get blank titre value and against standard solution made in 0.4 per cent oxalic acid to get standard titre value (V1).

The ascorbic acid content was quantified using the formula.

$$\text{Ascorbic acid (mg/100 g sample)} = \frac{\text{Ascorbic acid (mg) Content in standard}}{V_1 \text{ (blank)}} \times \frac{V_2 \text{ (sample)}}{\text{aliquot taken}} \times \frac{\text{Total volume of sample (ml)}}{\text{weight of sample}} \times 100$$

3.4.3.2 Percent dry matter in fruit (%)

The fruits are dried to get constant weight in hot air oven at 65 ^{0}C and percent dry matter content was calculated by using formula.

$$\text{Percent dry matter} = \frac{\text{Dry weight of the fruit}}{\text{Fresh weight of the fruit}} \times 100$$

3.4.2.3 Chlorophyll content in fruits (mg/100 g)

The total chlorophyll content in plant fruits was measured at harvesting by using dimethyl sulfoxide (DMSO) method given by Shoef and Lilum (1976).

Fresh fruit sample (100 mg) was incubated in 7.0 ml of DMSO at 65 ^{0}C for 50 min. At the end of incubation period, the supernatant was decanted and discarded the fruit tissue. The volume of the supernatant was made upto 10 ml with DMSO. The absorbance of the extract was observed at 645 nm and 663 nm by using DMSO as the blank of total chlorophyll in the sample was calculated by using the following formula.

$$\text{Total chlorophyll (mg/100 g)} = 20.00 \text{ at } A645 + 80.02\ A663 \times \frac{V}{1000 \times W \times a}$$

Where,

A : Absorbance of specific wave length 645 and 663 nm

V : Final volume of the chlorophyll extract

W : Fresh weight of the sample (g)

a : Path length of light (1 cm)

3.5 Statistical analysis

The data of the experiment were analyzed statistically following the procedure described by Panse and Sukhatme (1957). The level of significance used in ‘F’ test was P=0.05. Critical difference values were calculated wherever the ‘F’ test was significant.

3.6 Cost of cultivation, net returns and Benefit: Cost ratio

Cost of cultivation was calculated based on the prices of inputs that were prevailing in the market at the time of their use. The selling price for the produce was obtained from market. The net returns per hectare was calculated by deducting the cost of cultivation from gross income and expressed in rupees per hectare (Rs. per ha).

Net returns (Rs. per ha) = Gross income (Rs. per ha) – Cost of cultivation (Rs. per ha)

$$\text{Benefit: cost ratio} = \frac{\text{Net return (Rs. per ha)}}{\text{Total cost of cultivation (Rs. per ha)}}$$

4. EXPERIMENTAL RESULTS

The results of the field experiment conducted during 2015-16 at farmer field (Omanna), Neeralakatti village, Dharwad district to study the **Effect of soil test based INM practices on the performance of Chilli** are presented in this chapter.

As a part of this study the experiment plot was analyzed for its nutrient status. The details are furnished in appendix I. The soils of experiment site exhibited pH and EC of 7.65 and 0.65 respectively. The soils consisted of 13.93 % clay, 21.53 % silt and 33.77 % fine sand. The nutrient status has been also analyzed in respect of available N (181.88 kg/ha), Available P (70.78 kg/ha) and available K (149.7 kg/ha).

4.1 Growth parameters

4.1.1 Plant height

The plant height of chilli at 30 DAT, 60 DAT and 90 DAT was significantly influenced by different nutrient management practices and organic amendments.

The data furnished in the Table 1 revealed that, chilli plant recorded maximum plant height during 30 DAT (20.1 cm), 60 DAT (61.0 cm) and 90 DAT (80.4 cm) due to adoption INM a practice (M_2), which was on par with inorganic practice (M_3) at all crop growth stages. The lowest plant height was recorded in chilli with organic practice (M_1)

The plant height of chilli was also significantly influenced at all the stages by the application of organic amendments across different nutrient management practices. Application of Panchagavya spray @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1) imparts beneficial effect as manifested in increased plant height at all the stages of plant growth (61.4 cm at 60 DAT and 82.8 cm at 90 DAT). On the contrary, plants which were sprayed with water (S_4) proved to be shorter as exhibited by lower plant height (57.7cm at 60 DAT and 74.5 cm at 90 DAT).

Interaction effect of nutrient management practices and organic amendments did not differ significantly irrespective of the growth stages.

Table 1: Effect of nutrient management practices and organic amendments on plant height (cm) of chilli at different growth stages

Nutrient management practices	Organic amendments														
	Plant height at 30DAT (cm)					Plant height at 60DAT (cm)					Plant height at 90DAT (cm)				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
M_1	17.7	17.3	18.0	17.0	**17.5**	59.3	55.7	57.8	54.7	**56.9**	81.2	78.5	80.0	74.8	**78.6**
M_2	21.0	19.1	20.2	19.9	**20.1**	63.3	60.0	61.7	59.0	**61.0**	83.3	80.0	81.8	76.3	**80.4**
M_3	20.7	18.5	20.2	18.3	**19.4**	61.7	60.0	60.7	59.3	**60.4**	83.7	80.7	82.2	72.3	**79.7**
Mean	**19.8**	**18.3**	**19.4**	**18.4**	**19.0**	**61.4**	**58.6**	**60.1**	**57.7**	**59.4**	**82.8**	**79.7**	**81.3**	**74.5**	**79.6**
For comparing means of	**S.Em.±**		**CD at 5%**			**S.Em.±**		**CD at 5%**			**S.Em.±**		**CD at 5%**		
Nutrients	0.39		1.17			0.43		1.28			0.44		1.29		
Amendments	0.46		NS			0.50		1.48			0.50		1.49		
M X S	0.79		NS			0.87		NS			0.88		NS		

NS- Non-Significant RDN- Recommended Dose of Nitrogen DAT- Days After Transplanting

Factor I: Nutrient management practices.
M_1- Organic practice
M_2- INM practices (50 % organic + 50 % inorganic)
M_3-Inorganic practice

Factor II: Organic amendments.
S_1-Panchagavya spray @ 3 % + *Verticillium luccani* at 30 and 60 DAT
S_2-Cow urine spray @ 10 % + *Verticillium luccani* at 30 and 60 DAT
S_3- Jeevamrutha spray as it is + *Verticillium luccani* at 30 and 60 DAT
S_4- Control (water spray)

4.1.2 Number of primary branches per plant

The number of primary branches per plant was significantly influenced by nutrient management practices. Significantly higher number of primary branches per plant (1.9 at 30 DAT, 5.0 at 60 DAT and 6.1 at 90 DAT) were recorded due to adoption of INM practices (M_2), across different organic amendments (Table 2). The lowest number of primary branches per plant (1.7 at 30 DAT, 4.5 at 60 DAT and 5.6 at 90 DAT) were noticed due to organic practice (M_1), the results of which were on par with inorganic practice (M_3).

The number of primary branches per plant was significantly influenced by the application of organic amendments also at all the stages of crop growth except at 30 DAT. The application of panchagavya spray @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1) resulted in significantly higher number of primary branches per plant (5.3 at 60 DAT and 6.5 at 90 DAT) over other amendments at all the stages. This was followed by jeevamrutha spray + *Verticillium luccani* at 30 and 60 DAT (S_3). The lowest number of primary branches per plant (4.2 and 5.3 at 60 DAT and 90 DAT respectively) was recorded due to control *i.e.* water spray (S_4) and which was on par with cow urine spray @ 10 % + *Verticillium luccani* at 30 and 60 DAT (S_2).

The interaction effects of nutrient management practices and organic amendments at all the growth stages of the crop proved to be non significant.

4.1.3 Number of secondary branches per plant

The nutrient management practices and organic amendments significantly influenced the number of secondary branches per plant at all the stages of crop growth. Among nutrient management practices, significantly higher number of secondary branches per plant viz, 0.9, 10.1 and 12.2 were recorded with adoption of INM practices (M_2) at 30 DAT, 60 DAT and 90 DAT respectively over organic practice (M_1) and inorganic practice (M_3) at all the stages.

The number of secondary branches per plant was significantly influenced by the application of organic amendments too. Panchagavya spray @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1) recorded significantly higher number of secondary branches per plant of 10.7 and 13.0 at 60 DAT and 90 DAT respectively, followed by

Table 2: Effect of nutrient management practices and organic amendments on number of primary branches of chilli at different growth stages

Nutrient management practices	Organic amendments														
	Primary branches at 30DAT					Primary branches at 60DAT					Primary branches at 90DAT				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
M_1	1.8	1.6	1.6	1.6	**1.7**	5.1	4.0	5.0	3.8	**4.5**	6.1	5.5	5.9	5.0	**5.6**
M_2	2.0	1.8	1.9	1.8	**1.9**	5.8	5.0	5.0	4.3	**5.0**	6.9	5.8	6.2	5.6	**6.1**
M_3	1.8	1.7	1.8	1.7	**1.8**	5.1	4.1	4.5	4.5	**4.6**	6.6	5.3	5.8	5.3	**5.7**
Mean	**1.9**	**1.7**	**1.8**	**1.7**	**1.8**	**5.3**	**4.4**	**4.8**	**4.2**	**4.7**	**6.5**	**5.5**	**6.0**	**5.3**	**5.8**
For comparing means of	**S.Em.±**		**CD at 5%**			**S.Em.±**		**CD at 5%**			**S.Em.±**		**CD at 5%**		
Nutrients	0.045		0.13			0.14		0.41			0.096		0.28		
Amendments	0.052		NS			0.16		0.48			0.111		0.32		
M X S	0.091		NS			0.28		NS			0.193		NS		

NS- Non-Significant RDN- Recommended Dose of Nitrogen DAT- Days After Transplanting

Factor I: Nutrient management practices.
M_1- Organic practice
M_2- INM practices (50 % organic + 50 % inorganic)
M_3-Inorganic practice

Factor II: Organic amendments.
S_1-Panchagavya spray @ 3 % + *Verticillium luccani* at 30 and 60 DAT
S_2-Cow urine spray @ 10 % + *Verticillium luccani* at 30 and 60 DAT
S_3- Jeevamrutha spray as it is + *Verticillium luccani* at 30 and 60 DAT
S_4- Control (water spray)

Table 3: Effect of nutrient management practices and organic amendments on number of secondary branches of chilli at different growth stages

Nutrient management practices	Organic amendments														
	Secondary branches at 30DAT					Secondary branches at 60DAT					Secondary branches at 90DAT				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
M_1	0.9	0.8	0.8	0.8	**0.8**	10.1	8.1	9.9	7.6	**8.9**	12.1	11.1	11.9	10.0	**11.3**
M_2	1.0	0.9	1.0	0.9	**0.9**	11.6	10.0	10.1	8.7	**10.1**	13.7	11.5	12.3	11.3	**12.2**
M_3	0.9	0.9	0.9	0.8	**0.9**	10.3	8.3	9.1	8.9	**9.1**	13.2	10.5	11.5	10.6	**11.5**
Mean	**0.9**	**0.9**	**0.9**	**0.8**	**0.9**	**10.7**	**8.8**	**9.7**	**8.4**	**9.4**	**13.0**	**11.0**	**11.9**	**10.6**	**11.7**
For comparing means of	**S.Em.±**		**CD at 5%**			**S.Em.±**		**CD at 5%**			**S.Em.±**		**CD at 5%**		
Nutrients	0.022		0.067			0.28		0.83			0.19		0.56		
Amendments	0.026		NS			0.33		0.96			0.22		0.65		
M X S	0.045		NS			0.57		NS			0.38		NS		

NS- Non-Significant RDN- Recommended Dose of Nitrogen DAT- Days After Transplanting

Factor I: Nutrient management practices.
M_1- Organic practice
M_2- INM practices (50 % organic + 50 % inorganic)
M_3-Inorganic practice

Factor II: Organic amendments.
S_1-Panchagavya spray @ 3 % + *Verticillium luccani* at 30 and 60 DAT
S_2-Cow urine spray @ 10 % + *Verticillium luccani* at 30 and 60 DAT
S_3- Jeevamrutha spray as it is + *Verticillium luccani* at 30 and 60 DAT
S_4- Control (water spray)

jeevamrutha spray + *Verticillium luccani* at 30 and 60 DAT (S_3). The lowest number of secondary branches per plant (8.4 and 10.6 at 60 DAT and 90 DAT respectively) was recorded in chilli plants which were sprayed with water (S_4) and which was on par with cow urine spray@ 10 % + *Verticillium luccani* at 30 and 60 DAT (S_2).

Interaction effect of nutrient management practices and organic amendments were found non-significant at all the growth stages of the crop. The data pertaining to the number of secondary branches per plant is given in Table 3.

4.1.4 Stem thickness (cm)

Different nutrient management practices and organic amendments were significantly influenced the stem thickness of chilli at 30, 60 and 90 DAT. Stem thickness did not differ significantly due to interaction of nutrient management practices and organic amendments. The data pertaining to this is given in Table 4.

The data furnished in the Table 4 showed a significantly higher stem thickness (0.50 cm at 30 DAT, 1.1 cm at 60 DAT and 1.6 cm at 90 DAT) with INM practices (M_2), but it was on par with the plants nourished with inorganic practice (M_3) at 30 DAT. However, the lowest stem thickness (0.46 cm at 30 DAT, 0.8 cm at 60 DAT and 1.3 cm at 90 DAT) was recorded due to adoption of organic practice (M_1).

Panchagavya spray @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1) showed higher stem thickness of 1.2 cm and 1.7 cm at 60 DAT and 90 DAT respectively, across different nutrient management practices. There was no significant difference at 30 DAT. This was followed by jeevamrutha spray + *Verticillium luccani* at 30 and 60 DAT (S_3). However, lowest stem thickness of 0.8 cm and 1.1 cm was recorded with the control- water spray (S_4).

4.1.5 Leaf area index

The data presented in Table 5 clearly indicates that, the leaf area index differed significantly on account of adoption of different nutrient management practices and application of organic amendments, but did not differ significantly due to interaction effect of both the factors at all the growth stages of crop.

Table 4: Effect of nutrient management practices and organic amendments on stem thickness of chilli at different growth stages

Nutrient management practices	Organic amendments														
	Stem thickness at 30DAT (cm)					Stem thickness at 60DAT (cm)					Stem thickness at 90DAT (cm)				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
M_1	0.48	0.45	0.46	0.45	**0.46**	1.0	0.7	0.9	0.7	**0.8**	1.5	1.2	1.4	1.0	**1.3**
M_2	0.53	0.49	0.50	0.48	**0.50**	1.3	1.0	1.1	0.9	**1.1**	2.0	1.4	1.6	1.2	**1.6**
M_3	0.51	0.47	0.48	0.46	**0.48**	1.2	0.9	0.9	0.8	**0.9**	1.6	1.3	1.4	1.1	**1.4**
Mean	**0.5**	**0.47**	**0.48**	**0.46**	**0.48**	**1.2**	**0.9**	**1.0**	**0.8**	**1.0**	**1.7**	**1.3**	**1.5**	**1.1**	**1.4**
For comparing means of	**S.Em.±**		**CD at 5%**			**S.Em.±**		**CD at 5%**			**S.Em.±**		**CD at 5%**		
Nutrients	0.009		0.028			0.031		0.09			0.038		0.11		
Amendments	0.011		NS			0.035		0.10			0.044		0.13		
M X S	0.024		NS			0.062		NS			0.077		NS		

NS- Non-Significant RDN- Recommended Dose of Nitrogen DAT- Days After Transplanting

Factor I: Nutrient management practices.
M_1- Organic practice
M_2- INM practices (50 % organic + 50 % inorganic)
M_3-Inorganic practice

Factor II: Organic amendments.
S_1-Panchagavya spray @ 3 % + *Verticillium luccani* at 30 and 60 DAT
S_2-Cow urine spray @ 10 % + *Verticillium luccani* at 30 and 60 DAT
S_3- Jeevamrutha spray as it is + *Verticillium luccani* at 30 and 60 DAT
S_4- Control (water spray)

Table 5: Effect of nutrient management practices and organic amendments on leaf area index of chilli at different growth stages

Nutrient management practices	Organic amendments														
	Leaf area index at 30DAT					Leaf area index at 60DAT					Leaf area index at 90DAT				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
M_1	0.05	0.05	0.05	0.05	**0.05**	0.22	0.16	0.18	0.14	**0.17**	0.22	0.21	0.22	0.20	**0.21**
M_2	0.06	0.06	0.06	0.06	**0.06**	0.24	0.19	0.20	0.18	**0.20**	0.28	0.24	0.27	0.23	**0.25**
M_3	0.06	0.05	0.05	0.05	**0.05**	0.20	0.18	0.19	0.17	**0.18**	0.25	0.22	0.23	0.21	**0.22**
Mean	**0.056**	**0.053**	**0.053**	**0.053**	**0.054**	**0.22**	**0.17**	**0.19**	**0.16**	**0.18**	**0.25**	**0.22**	**0.24**	**0.21**	**0.23**
For comparing means of	**S.Em.±**		**CD at 5%**			**S.Em.±**		**CD at 5%**			**S.Em.±**		**CD at 5%**		
Nutrients	0.0011		0.0034			0.0039		0.011			0.0023		0.0068		
Amendments	0.0013		NS			0.0046		0.013			0.0026		0.0078		
M X S	0.0023		NS			0.0079		NS			0.0046		NS		

NS- Non-Significant RDN- Recommended Dose of Nitrogen DAT- Days After Transplanting

Factor I: Nutrient management practices.
M_1- Organic practice
M_2- INM practices (50 % organic + 50 % inorganic)
M_3-Inorganic practice

Factor II: Organic amendments.
S_1-Panchagavya spray @ 3 % + *Verticillium luccani* at 30 and 60 DAT
S_2-Cow urine spray @ 10 % + *Verticillium luccani* at 30 and 60 DAT
S_3- Jeevamrutha spray as it is + *Verticillium luccani* at 30 and 60 DAT
S_4- Control (water spray)

The leaf area index was significantly differed by the different nutrient management practices, across organic amendments. Significantly higher leaf area index of 0.06, 0.20 and 0.25 was recorded due to INM practices (M_2) at 30 DAT, 60 DAT and 90 DAT respectively, but the result were on par with inorganic practice (M_3) at 30 DAT. However, the lowest leaf area index of 0.05, 0.17 and 0.21 was recorded at 30 DAT, 60 DAT and 90 DAT respectively when chilli was grown with organic practice (M_1).

The leaf area index was also significantly influenced by the application of organic amendments at all the growth stages of crop except at 30 DAT. The application of panchagavya @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1) showed higher leaf area index of 0.22 and 0.25 at 60 DAT and 90 DAT respectively and this was followed by jeevamrutha + *Verticillium luccani* at 30 and 60 DAT (S_3) and cow urine spray @ 10 % + *Verticillium luccani* at 30 and 60 DAT (S_2). However, the lowest leaf area index of 0.16 and 0.21 was observed when crop was sprayed with the water (S_4) at 60 DAT and 90 DAT respectively.

4.2 Earliness parameters

4.2.1 Days to first flowering

The days to first flowering differed significantly due to different nutrient management practices across different organic amendments used. According to data present in Table 6 shows, the minimum (37.6) number of days to attain first flowering was noticed in the plants which were managed with INM practice. Plants grown with inorganic practices (M_3) took maximum (39.3) number of days to induce first flowering.

The days to first flowering was also differed significantly due to adoption of different organic amendments. Panchagavya spray @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1) recorded minimum (37.2) number of days for first flowering across nutrient management practices, which was followed by jeevamrutha + *Verticillium luccani* at 30 and 60 DAT (S_3) (38.1). Plants which were sprayed with water (S_4) took maximum (39.9) number of days to first flowering.

Interaction effect of nutrient management practices and organic amendments did not show significant results with respect to number of days to first flowering.

Table 6: Effect of nutrient management practices and organic amendments on earliness parameters of chilli

Nutrient management practices	Organic amendments									
	Days to first flowering					Days to 50 per cent flowering				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
M_1	37.2	39.3	37.9	40.4	**38.7**	47.0	48.6	47.9	49.7	**48.2**
M_2	36.0	38.2	37.2	38.8	**37.6**	44.8	48.2	46.9	48.5	**47.1**
M_3	38.3	39.4	39.1	40.5	**39.3**	48.2	49.3	48.7	49.5	**48.9**
Mean	**37.2**	**39.0**	**38.1**	**39.9**	**38.5**	**46.7**	**48.7**	**47.7**	**49.2**	**48.1**
For comparing means of	**S.Em.±**		**CD at 5%**			**S.Em.±**		**CD at 5%**		
Nutrients	0.20		0.61			0.22		0.67		
Amendments	0.24		0.70			0.26		0.77		
M X S	0.41		NS			0.45		NS		

NS- Non-Significant

RDN- Recommended Dose of Nitrogen

Factor I: Nutrient management practices.
M_1- Organic practice
M_2- INM practices (50 % organic + 50 % inorganic)
M_3-Inorganic practice

Factor II: Organic amendments.
S_1-Panchagavya spray @ 3 % + *Verticillium luccani* at 30 and 60 DAT
S_2-Cow urine spray @ 10 % + *Verticillium luccani* at 30 and 60 DAT
S_3- Jeevamrutha spray as it is + *Verticillium luccani* at 30 and 60 DAT
S_4- Control (water spray)

4.2.2 Days to 50 per cent flowering

The number of days to 50 per cent flowering differed significantly due to nutrient management practices and application of organic amendments (Table 6).

The minimum (47.1) number of days to 50 per cent flowering was recorded in chilli which was grown with the INM practice (M_2). On the contrary, the maximum (48.9) days to 50 per cent flowering was observed in chilli which was raised with inorganic practice.

The days to 50 per cent flowering was significantly influenced by the different organic amendments too. Application of panchagavya spray @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1) imparts beneficial effect as manifested in minimum (46.7) days to 50 per cent flowering, which was followed by jeevamrutha spray + *Verticillium luccani* at 30 and 60 DAT (S_3) (47.7). Chilli took maximum (49.2) number of days to 50 per cent flowering when it was subjected to water spray (S_4).

4.3 Yield parameters

4.3.1 Number of flowers per cluster

The data presented in Table 7 obviously indicates that, the number of flowers per cluster was not significantly differed due to adoption of different nutrient management practices, application of organic amendments and their interaction effects.

4.3.2 Number of fruits per cluster

The data given in Table 7 further indicates that, the number of fruits per cluster did not differ significantly on account of adoption of nutrient management practices, application of organic amendments and their interaction effects.

4.3.3 Number of flowers per plant

The number of flower per plant of chilli was significantly influenced by different nutrient management practices and organic amendments but did not show significant difference due to their interaction effects.

Table 7: Effect of nutrient management practices and organic amendments on number of flowers and fruits per cluster of chilli

Nutrient management practices	Organic amendments									
	Number of flowers per cluster					Number of fruits per cluster				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
M_1	1.1	1.1	1.1	1.0	1.1	1.0	0.9	1.0	0.9	1.0
M_2	1.1	1.1	1.1	1.1	1.1	1.0	1.0	0.9	0.9	1.0
M_3	1.1	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9
Mean	1.1	1.1	1.1	1.0	1.1	1.0	0.9	1.0	0.9	1.0
For comparing means of	S.Em.±		CD at 5%			S.Em.±		CD at 5%		
Nutrients	0.021		NS			0.022		NS		
Amendments	0.025		NS			0.025		NS		
M X S	0.043		NS			0.044		NS		

NS- Non-Significant

RDN- Recommended Dose of Nitrogen

Factor I: Nutrient management practices.
M_1- Organic practice
M_2- INM practices (50 % organic + 50 % inorganic)
M_3-Inorganic practice

Factor II: Organic amendments.
S_1-Panchagavya spray @ 3 % + *Verticillium luccani* at 30 and 60 DAT
S_2-Cow urine spray @ 10 % + *Verticillium luccani* at 30 and 60 DAT
S_3- Jeevamrutha spray as it is + *Verticillium luccani* at 30 and 60 DAT
S_4- Control (water spray)

The data furnished in Table 8 clearly shows that, significantly higher (471.3) number of flowers per plant were obtained in chilli which was adopted with INM practices (M_2) over inorganic nutrient management practices (M_3) (467.0). The chilli grown with organic practice (M_1) resulted in less (461.4) number of flowers per plant.

The application of panchagavya spray @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1) showed positive response as manifested in significantly higher (478.1) number of flower per plant over other amendments. However, the lowest (455.9) number of flower per plant was recorded due to water spray (S_4).

4.3.4 Number of fruits per plant

The data mentioned in Table 8 indicates that, the number of fruits per plant of chilli was significantly influenced by different nutrient management practices and organic amendments but no significant results were observed due to interaction effects.

Significantly higher number of fruits per plant (212.8) was recorded in chilli which was raised with INM practice (M_2) when compared to other nutrient management practices. However, inorganic practice (204.5) and organic practice (203.9) were on par with each other regarding number of fruits per plant.

Among organic amendments, the application of panchagavya spray @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1) recorded significantly higher number of fruits per plant (222.9) over other amendments like jeevamrutha + *Verticillium luccani* at 30 and 60 DAT (S_3) (209.1), cow urine spray @ 10 % + *Verticillium luccani* at 30 and 60 DAT (S_2) (201.7). The lowest (194.5) number of fruits per plant was recorded in chilli when it was subjected to water spray (S_4).

4.3.5 Percent fruit set (%)

The data pertaining to the percent fruit set of chilli as influenced by the different nutrient management practices and organic amendments have been furnished in Table 8.

Table 8: Effect of nutrient management practices and organic amendments on number of flowers, fruits per plant and per cent fruit set of chilli

Nutrient management practices	Organic amendments														
	Number of flowers per plant					Number of fruits per plant					Per cent fruit set (%)				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
M_1	473.2	453.5	467.9	451.0	**461.4**	220.8	198.8	203.6	192.4	**203.9**	46.3	43.8	43.5	42.7	**44.1**
M_2	485.6	464.8	473.8	460.9	**471.3**	231.2	205.6	217.0	197.4	**212.8**	47.6	44.2	45.8	42.8	**45.1**
M_3	475.4	468.5	468.2	455.9	**467.0**	216.8	200.7	206.7	193.6	**204.5**	45.6	42.8	44.1	42.5	**43.8**
Mean	**478.1**	**462.3**	**470.0**	**455.9**	**466.6**	**222.9**	**201.7**	**209.1**	**194.5**	**207.1**	**46.5**	**43.6**	**44.5**	**42.7**	**44.4**
For comparing means of	**S.Em.±**		**CD at 5%**			**S.Em.±**		**CD at 5%**			**S.Em.±**		**CD at 5%**		
Nutrients	1.25		3.68			1.53		4.50			0.32		0.94		
Amendments	1.44		4.25			1.77		5.20			0.37		1.08		
M X S	2.51		NS			3.07		NS			0.64		NS		

NS- Non-Significant

RDN- Recommended Dose of Nitrogen

Factor I: Nutrient management practices.
M_1- Organic practice
M_2- INM practices (50 % organic + 50 % inorganic)
M_3-Inorganic practice

Factor II: Organic amendments.
S_1-Panchagavya spray @ 3 % + *Verticillium luccani* at 30 and 60 DAT
S_2-Cow urine spray @ 10 % + *Verticillium luccani* at 30 and 60 DAT
S_3- Jeevamrutha spray as it is + *Verticillium luccani* at 30 and 60 DAT
S_4- Control (water spray)

The per cent fruit set was differed significantly with respect to adoption of different nutrient management practices and application of organic amendments. But there was no significant difference with respect to interaction effects.

The data indicates superiority of INM practice (M_2) as manifested in higher (45.1 %) per cent fruit set. Lowest (43.8 %) per cent fruit set was observed in chilli grown with inorganic practice (M_3). The result of inorganic practice was on par with organic practice (44.1 %).

Among organic amendments, the application of panchagavya spray @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1) recorded significantly higher per cent fruit set (46.5 %), which was followed by jeevamrutha + *Verticillium luccani* at 30 and 60 DAT (S_3) (44.5 %). However, chilli raised with cow urine spray @ 10 % + *Verticillium luccani* at 30 and 60 DAT (S_2) (43.6 %) and control- water spray (S_4) (42.7 %) were on par with each other for per cent fruit set.

4.3.6 Average fruit weight (g)

The data given in Table 9 indicates that, the different nutrient management practices, organic amendments and their interaction effect differed significantly with respect to average fruit weight.

Among different nutrient management practices, INM practice (M_2) had favourable effect as manifested in higher average fruit weight of 5.1 g which was on par with organic practice (5.0 g). However, plants supplied with inorganic nutrients (M_3) recorded lowest average fruit weight of 4.8 g.

The application of panchagavya spray @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1) proved to be effective as exhibited by higher average fruit weight of 5.3 g, which was on par with jeevamrutha spray + *Verticillium luccani* at 30 and 60 DAT (S_3) (5.2 g). On the contrary, the lowest (4.5 g) average fruit weight was recorded when chilli was subjected to water spray (S_4)

Among interaction, M_2S_1 (5.5 g) showed higher average fruit weight which was on par with M_2S_3 (5.4 g), M_3S_1 (5.3 g) and M_1S_1 (5.3 g). The lowest average fruit weight was recorded due to M_3S_4 (4.2 g).

Table 9: Effect of nutrient management practices and organic amendments on average fruit weight, yield per plant and yield per plot of chilli

Nutrient management practices	Organic amendments														
	Average fruit weight (g)					Yield per plant (kg)					Yield per plot (kg)				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
M_1	5.3	4.8	5.0	4.7	**5.0**	1.5	1.5	1.5	1.5	**1.5**	31.8	29.3	30.8	28.1	**30.0**
M_2	5.5	5.1	5.4	4.5	**5.1**	1.9	1.6	1.6	1.6	**1.7**	34.6	31.8	33.0	30.3	**32.4**
M_3	5.3	4.7	5.1	4.2	**4.8**	1.6	1.5	1.5	1.4	**1.5**	33.2	30.4	31.9	28.3	**31.0**
Mean	**5.3**	**4.9**	**5.2**	**4.5**	**5.0**	**1.7**	**1.5**	**1.5**	**1.5**	**1.6**	**33.2**	**30.5**	**31.9**	**28.9**	**31.1**
For comparing means of	**S.Em.±**		**CD at 5%**			**S.Em.±**		**CD at 5%**			**S.Em.±**		**CD at 5%**		
Nutrients	0.049		0.14			0.028		0.082			0.23		0.68		
Amendments	0.056		0.16			0.032		0.095			0.27		0.79		
M X S	0.098		0.28			0.056		NS			0.46		NS		

NS- Non-Significant

RDN- Recommended Dose of Nitrogen

Factor I: Nutrient management practices.
M_1- Organic practice
M_2- INM practices (50 % organic + 50 % inorganic)
M_3-Inorganic practice

Factor II: Organic amendments.
S_1-Panchagavya spray @ 3 % + *Verticillium luccani* at 30 and 60 DAT
S_2-Cow urine spray @ 10 % + *Verticillium luccani* at 30 and 60 DAT
S_3- Jeevamrutha spray as it is + *Verticillium luccani* at 30 and 60 DAT
S_4- Control (water spray)

4.3.7 Yield per plant (kg)

The yield per plant differed significantly due to different nutrient management practices and organic amendments but did not show significant result due to interaction effect. The data related to yield per plant is given in the Table 9.

Among different nutrient management practices, INM (M_2) resulted in significantly higher (1.7 kg) yield per plant across different organic amendments. However, the lowest yield per plant was obtained in those plants which were grown with the inorganic practice (1.5 kg) and organic practice (1.5 kg).

Among organic amendments, the application of panchagavya spray @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1) resulted in significantly higher (1.7 kg) yield per plant when compared to other organic amendments, which were on par with each other.

4.3.8 Yield per plot (kg)

The data with respect to yield per plot is mentioned in Table 9. Nutrient management practices and application of organic amendments significantly influenced the yield per plot.

Significantly higher (32.4 kg) yield per plot was recorded in chilli when it was raised with INM practice (M_2) which was followed by inorganic practice (31.0 kg) and lowest (30.0 kg) yield was recorded with organic practice (M_1).

Among organic amendments, application of panchagavya spray @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1) recorded significantly higher (33.2 kg) yield per plot which was followed by jeevamrutha spray + *Verticillium luccani* at 30 and 60 DAT (S_3) (31.9 kg). However, the lowest (28.9 kg) yield per plot was recorded in chilli when it was sprayed with water (S_4).

4.3.9 Yield per hectare (t)

The data pertaining to the yield of chilli as influenced by nutrient management practices and organic amendments has been furnished in Table 10. The data revealed that productivity (yield per hectare) of chilli differed significantly due to nutrient management practices and organic amendments. However, interaction effects did not show any significant difference.

Table 10: Effect of nutrient management practices and organic amendments on yield per hectare and dry matter content in plant of chilli

Nutrient management practices	Organic amendments									
	Yield per hectare (t)					Dry matter content in plant (%)				
	S_1	**S_2**	**S_3**	S_4	**Mean**	**S_1**	**S_2**	**S_3**	**S_4**	**Mean**
M_1	26.1	24.1	25.3	23.2	**24.7**	57.0	50.7	55.4	50.4	**53.4**
M_2	28.5	26.2	27.2	24.9	**26.7**	65.8	62.6	64.1	54.5	**61.8**
M_3	27.4	25.0	26.3	23.3	**25.5**	63.9	56.8	58.0	54.2	**58.2**
Mean	**27.3**	**25.1**	**26.3**	23.8	**25.6**	**62.3**	**56.7**	**59.2**	**53.0**	**57.8**
For comparing means of	**S.Em.±**		**CD at 5%**			**S.Em.±**		**CD at 5%**		
Nutrients	0.19		0.56			0.61		1.81		
Amendments	0.22		0.65			0.71		2.09		
M X S	0.38		NS			1.23		NS		

NS- Non-Significant

RDN- Recommended Dose of Nitrogen

Factor I: Nutrient management practices.
M_1- Organic practice
M_2- INM practices (50 % organic + 50 % inorganic)
M_3-Inorganic practice

Factor II: Organic amendments.
S_1-Panchagavya spray @ 3 % + *Verticillium luccani* at 30 and 60 DAT
S_2-Cow urine spray @ 10 % + *Verticillium luccani* at 30 and 60 DAT
S_3- Jeevamrutha spray as it is + *Verticillium luccani* at 30 and 60 DAT
S_4- Control (water spray)

The data with respect to yield per hectare indicates superiority of INM practice (M_2) as manifested in significantly higher yield (26.7 t/ha), which was followed by chilli grown with inorganic practice (M_3) (25.5 t/ha). The lowest yield per hectare was observed due to adoption of organic practice (M_1) (24.7 t/ha).

The application of panchagavya spray @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1) recorded significantly higher yield per hectare (27.3 t/ha) which was followed by jeevamrutha spray + *Verticillium luccani* at 30 and 60 DAT (S_3) (26.3 t/ha). However, the lowest (23.8 t/ha) yield per hectare was recorded in chilli when it was sprayed with water (S_4).

4.3.10 Dry matter content of the plant (%)

The dry matter content of the plant differed significantly due to adoption of different nutrient management practices as well as organic amendments. The interaction effects of nutrient management practices and organic amendments did not show significant difference.

The data given in the Table 10 indicates that, significantly higher (61.8 %) dry matter content of the plant was recorded in chilli when it was grown with INM practice (M_2), across different organic amendments. which was, followed by inorganic practice (58.2 %). Further, the lowest (53.4 %) dry matter content of the plant was observed with organic practice (M_1).

Significantly highest dry matter content of the plant (62.3%) was recorded in chilli when it was sprayed with panchagavya @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1), which was followed by jeevamrutha spray + *Verticillium luccani* at 30 and 60 DAT (S_3) (59.2 %). The lowest (53.0 %) dry matter content was recorded in chilli when it was subjected to water spray (S_4).

4.4 Quality parameters

4.4.1 Ascorbic acid content (mg/100 g)

The ascorbic acid content differed significantly due to different nutrient management practices, application of organic amendments and their interaction effects (Table 11).

Table 11: Effect of nutrient management practices and organic amendments on quality parameter of chilli

Nutrient management practices	Organic amendments														
	Ascorbic acid (mg/ 100g)					Per cent dry matter in fruits (%)					Total Chlorophyll (mg/ 100g)				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
M_1	237.8	186.3	201.3	150.2	**193.9**	20.2	18.4	19.0	19.0	**19.2**	2.1	2.0	2.1	1.6	**1.9**
M_2	263.6	145.6	151.1	128.9	**172.3**	20.9	19.2	20.3	18.9	**19.8**	1.7	1.3	1.6	1.3	**1.5**
M_3	199.8	151.2	163.3	142.1	**164.1**	20.4	19.5	19.2	18.4	**19.4**	1.5	1.1	1.3	1.0	**1.2**
Mean	**233.7**	**161.1**	**171.9**	**140.4**	**176.8**	**20.5**	**19.0**	**19.5**	**18.8**	**19.5**	**1.8**	**1.5**	**1.7**	**1.3**	**1.5**
For comparing means of	**S.Em.±**		**CD at 5%**			**S.Em.±**		**CD at 5%**			**S.Em.±**		**CD at 5%**		
Nutrients	0.90		2.66			0.12		0.35			0.012		0.036		
Amendments	1.04		3.07			0.14		0.41			0.014		0.042		
M X S	1.81		5.32			0.24		0.71			0.024		0.073		

NS- Non-Significant

RDN- Recommended Dose of Nitrogen

Factor I: Nutrient management practices.
M_1- Organic practice
M_2- INM practices (50 % organic + 50 % inorganic)
M_3-Inorganic practice

Factor II: Organic amendments.
S_1-Panchagavya spray @ 3 % + *Verticillium luccani* at 30 and 60 DAT
S_2-Cow urine spray @ 10 % + *Verticillium luccani* at 30 and 60 DAT
S_3- Jeevamrutha spray as it is + *Verticillium luccani* at 30 and 60 DAT
S_4- Control (water spray)

Among different nutrient management practices, chilli raised with organic practice (M_1) recorded significantly higher (193.9 mg/100 g) ascorbic acid content, which was followed by INM practice (172.3 mg/100 g). However, the chilli grown with the inorganic practice (M_3) showed lowest (164.1 mg/100 g) ascorbic acid content.

The application of panchagavya spray @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1) recorded significantly higher (233.7 mg/100 g) ascorbic acid content, which was followed by jeevamrutha spray + *Verticillium luccani* at 30 and 60 DAT (S_3) (171.9 mg/100 g). However, the lowest ascorbic acid content (140.4 mg/100 g) was recorded in chilli plants which were sprayed with water (S_4).

Among interaction effects, M_2S_1 (263.6 mg/100 g) showed higher ascorbic acid content which was followed by M_1S_1 (237.8 mg/100 g), M_1S_3 (201.3 mg/100 g) and M_3S_1 (199.8 mg/100 g). The lowest ascorbic acid content was recorded due to M_3S_4 (142.1 mg/100 g).

4.4.2 Percent dry matter in fruit (%)

The percent dry matter in fruit differed significantly due to adoption of different nutrient management practices, application of various organic amendments and their interaction effects. The data with respect to per cent dry matter in fruit is furnished in Table 11.

Significantly higher (19.8 %) per cent of dry matter in fruit was recorded in chilli plants subjected to INM practice (M_2). However, chilli grown with organic practice (M_1) recorded lowest (19.2 %) per cent dry matter in fruit which was on par with inorganic practice (19.4 %).

Panchagavya spray @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1) had resulted in significantly higher (20.5 %) per cent dry matter in fruit among different organic amendments, which was followed by jeevamrutha spray +*Verticillium luccani* at 30 and 60DAT (S_3) (19.5 %). However, the lowest percent dry matter in fruit (18.8 %) was recorded in chilli which was subjected to water spray (S_4).

The interaction effects of nutrient management practices and organic amendments showed the higher percent dry matter in fruit due to M_2S_1 (20.9 %) which was statistically on par with M_3S_1 (20.4 %), M_2S_3 (20.3 %) and M_1S_1 (20.2 %). The lowest percent dry matter in fruit was recorded in chilli due to M_3S_4 (18.4 %) and M_1S_2 (18.4 %).

4.4.3 Chlorophyll content in fruits (mg/100 g)

The Table 11 shows that, the **c**hlorophyll content in fruits differed significantly on account of adoption of nutrient management practices, use of organic amendments and their interaction effects.

Chilli grown with organic nutrient practice (M_1) proved to have a significantly higher (1.9 mg/100 g) chlorophyll content in fruits, which was followed by INM practice (1.5 mg/100 g). The inorganic practice (M_3) showed the lowest (1.2 mg/100 g) chlorophyll content.

Among organic amendments, panchagavya spray @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1) recorded significantly higher (1.8 mg/100 g) chlorophyll content across different nutrient management practices, which was followed by jeevamrutha spray + *Verticillium luccani* at 30 and 60 DAT (S_3) (1.7 mg/100 g) However, the lowest (1.3 mg/100 g) chlorophyll content was recorded with chilli plants which were sprayed with water (S_4).

Among interaction effects, M_1S_1 and M_1S_3 recorded highest (2.1 mg/100 g) chlorophyll content which were followed by M_1S_2 (2.0 mg/100 g) and M_2S_1 (1.7 mg/100 g). The lowest chlorophyll content was recorded due to interaction of M_3S_4 (1.0 mg/100 g).

4.5 Economics

4.5.1 Gross return and Net return (Rs.)

The gross return and net return were differed with the different nutrient management practices and organic amendments. The data is presented in Table 12.

Table 12: Effect of nutrient management practices and organic amendments on gross, net income and cost: benefit ratio of chilli

Nutrient management practices	Organic amendments														
	Gross Income (Rs.)					Net Income (Rs.)					Benefit : Cost Ratio				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
M_1	209163	192702	202798	185240	**197476**	141263	125672	133998	118240	**129793**	2.1	1.9	1.9	1.8	**1.9**
M_2	227818	209602	217503	199506	**213607**	169918	152572	158703	142506	**155925**	2.9	2.7	2.7	2.5	**2.7**
M_3	218820	199945	210260	186118	**203786**	161620	143615	152160	129818	**146803**	2.8	2.5	2.6	2.3	**2.6**
Mean	**218600**	**200749**	**210187**	**190288**	**204956**	**157600**	**140619**	**148287**	**130188**	**144174**	**2.6**	**2.4**	**2.4**	**2.2**	**2.4**

NS- Non-Significant

RDN- Recommended Dose of Nitrogen

Factor I: Nutrient management practices.

M_1- Organic practice

M_2- INM practices (50 % organic + 50 % inorganic)

M_3-Inorganic practice

Factor II: Organic amendments.

S_1-Panchagavya spray @ 3 % + *Verticillium luccani* at 30 and 60 DAT

S_2-Cow urine spray @ 10 % + *Verticillium luccani* at 30 and 60 DAT

S_3- Jeevamrutha spray as it is + *Verticillium luccani* at 30 and 60 DAT

S_4- Control (water spray)

Note: Selling rate of green chilli – Rs. 8 per kg.

Highest gross return (Rs. 213607/ha) and net return (Rs. 155925/ha) were realized in chilli which was raised with INM practice (M_2). However, the lowest gross return (Rs. 197476/ha) and net return (Rs. 129793/ha) were recorded in chilli which was grown with organic practice (M_1).

The application of panchagavya spray @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1) recorded higher gross return (Rs. 218600/ha) and net return (Rs. 157600/ha). However, the lowest gross return (Rs. 190288/ha) and net return (Rs. 130188/ha) were recorded with the chilli subjected to water spray (S_4).

4.5.2 Benefit: Cost ratio

The data furnished in Table 12 obviously indicates that, the Benefit: Cost ratio differed with the adoption of different nutrient management practices and application of organic amendments.

Among nutrient management practices, INM practice (M_2) recorded the highest Benefit: Cost ratio (2.7) and it was followed by inorganic practice (M_3). However, the lowest (1.9) Benefit: Cost ratio was recorded with organic practice (M_1)

The application of panchagavya + *Verticillium luccani* at 30 and 60 DAT (S_1) recorded highest (2.6) Benefit: Cost ratio among organic amendments. This was followed by jeevamrutha spray + *Verticillium luccani* at 30 and 60 DAT (S_3) and cow urine spray + *Verticillium luccani* at 30 and 60 DAT (S_2). The lowest (2.2) Benefit: Cost ratio was observed due to water spray (S_4).

Among interactions, M_2S_1 recorded highest Benefit: Cost ratio of 2.9, which was followed by M_3S_1 (2.8), M_2S_2 (2.7) and M_2S_3 (2.7). The lowest Benefit: Cost ratio was recorded in M_1S_4 (1.8).

5. DISCUSSION

The results of the field experiment on **"Effect of soil test based INM practices on the performance of Chilli"** conducted during 2015-16 at farmer field (Omanna), Neeralakatti, Dharwad district are discussed in this chapter.

The crop growth is mainly dependent on environmental factors. Fluctuations in weather conditions greatly influence the crop growth, development and yield. During the experimentation, 527.00 mm rainfall was received during cropping period from August-2015 to January- 2016. However, the distribution of rainfall during cropping period was not uniform and there was soil moisture deficit. The mean maximum temperature was 30.09 ^{0}C and the mean minimum temperature was 18.14 ^{0}C. In this investigation, an attempt was made to study the

5.1 Impact of different nutrient management practices and organic amendments on the performance of chilli.

5.2 Economics of different nutrient management practices and organic amendments on the performance of chilli.

5.1 Impact of different nutrient management practices and organic amendments on the performance of chilli

5.1.1 Effect on growth parameters

The growth parameters of chilli were significantly influenced by different nutrient management practices and organic amendments at all the growth stages. Growth parameters *viz.* plant height, number of primary and secondary branches per plant, stem thickness and leaf area index were greatly and positively influenced by adoption of INM practices (M_2) across different organic amendments. Significant increase in plant height, stem thickness, number of branches due to INM practices may be attributed to various reasons.

In case of INM practices plants are supplemented both organic and inorganic components in specific proportion, which facilitates balanced supply of nutrients to the crops. When blend of both organics and inorganics are used, plants will tend to

share nutrients in time dimension as chemical fertilizers will be made available to plants soon after the application which will be complimentary to the slow release of nutrients when supplemented through organic sources. Further, application of organic manures like FYM in soil will be subjected to slower mineralization which ensures steady supply of nutrients to the plants throughout its active growing season, except at initial stage of crop growth and development during which chemical fertilizers will take care of plant growth and development. The superiority of INM practice in chilli might be attributed to greater supply of nutrients as it includes both inorganic and organic source of nutrients which are known to improve soil physico-chemical and biological properties.

These findings are in conformity with those of Hangarge *et al.* (2001) who recorded significantly higher growth parameters of chilli, when it was supplemented with combined application of vermi compost and chemical fertilizers when compared to application of either of organic manure or chemical fertilizers alone. Talukder and Jana (2009) opined that 100% recommended dose of N-fertilizer @ 80 kg and farmyard manure @ 15 tonnes/ha resulted in vigorous plant growth. Further, Deshpande *et al.* (2010) also reported similar results in chilli. When chilli was grown with chemical fertilizers like Nitrogen 125 Kg/ha and organic fertilizers like FYM @ 10 t/ha + *Azospirillum* resulted in plants of higher vigour which was reflected in higher plant height, number of branches per plant. Similar findings have been reported by Malik *et al.* (2011). According to his version sweet pepper hybrid SH-SP-5 was influenced by integration of inorganic fertilizers and organic manures. These results were further confirmed by subjecting chilli to the 50% NPK + 50% FYM + bio fertilizers by Samsangheile and kanaujia (2014). Leela Rani *et al.* (2015) also observed that, the combined application of 150 kg N/ha along with 10t FYM and 0.5 t neem cake/ha resulted in increased plant height, canopy spread and number of branches per plant. Vikash kumar *et al.* (2016) reported that application of 25 t FYM/ha along with RDF (100:50:50 NPK Kg/ha) recorded higher plant height.

Chilli grown with only organic practices was found relatively less vigorous than those grown with INM practices as indicated by the moderate growth parameters. It is quite evident from the results that, when N was supplied through FYM, growth and development of chilli plants were moderate, which might be ascribed to slower

mineralization of organic manures and non-availability of nutrients in adequate amounts especially during early stages of crop growth.

Application of different organic amendments imparted beneficial effects on the performance of chilli in respect of vegetative parameters. The growth parameters were significantly influenced by the application of organic amendments at all the growth stages of crop except at 30 DAT. This is because the application of organic amendments was started after 30 DAT so there was no effect of organic amendments at 30DAT.

The application of panchagavya spray @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1) showed better performance with respect to growth parameters. It is always perceived that, use of organic amendments tend to supplement nutritional requirement of crops, besides their positive impact on the qualitative parameters of the crops. There is plenty of research information regarding beneficial effects of organic amendments in crop cultivation. In this study it is asserted that application of organic amendments like panchagavya in combination with bio agents bring considerable changes in plant growth and development, as evident from chilli plants of taller stature with favourable leaf area index. The beneficial effects of organic amendments have been reported by several scientists which are in conformity with the study conducted by Shwetha and Babalad, 2008. They reported beneficial effect of panchagavya along with organics in soybean based cropping system. They also recorded higher soil biological activities and improved nutrient uptake of soybean due to influence exerted by panchagavya. Further, Nileema and Sreenivasa (2011) also reported the nutrient content of panchagavya and it contains nutrients like N, P, K, Zn, Cu, Fe, Mn. In addition to this, they also reported that, it has beneficial microbes in it so as to enhance growth characters in chilli. Monika rana *et al.* (2015) revealed that panchagavya along with organic manures showed significantly enhanced microbial population and crop growth in different cropping system. Endorsing the views of above scientist, Ponnumani and Semmalar (2015) also opined that the use of panchagavya results in significantly higher growth parameter in chilli compared to others. Rao *et al.* (2014) observed that, use of panchagavya along with vermi compost enhanced the growth parameters like height of plant, number of branches as compared to those plants which were grown on vermi compost alone.

5.1.2 Earliness parameters

Induction of first flowering and 50 per cent flowering were influenced by both nutrient management practices and use of organic amendments. The beneficial effect of INM practice was noticed as evident from less number of days taken for induction of flowering. These results corroborate the findings of Surya kumari *et al.* (2009).They stated that, integrated use of vermi compost and chemical fertilizers took minimum days to 50 % flowering. Further, findings of Deshpande *et al.* (2010) and Vikash kumar *et al.* (2016) were almost in conformity with the results of this study.

Panchagavya spray @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1) took minimum days to first flowering and 50 % flowering. On the contrary, the chilli took maximum days for these activities when it was sprayed with water. Similarly, Somasundaram and Singaram (2006) also reported that the panchagavya had higher content of P and K compared to other amendments and these elemental nutrients present in panchagavya helps in earlier flowering.

5.1.3 Yield parameters

Number of flowers and fruits per plant, average fruit weight, yield per plant, plot, hectare and dry matter content of plant differed significantly as evident from their higher values due to INM practice, when compared to other nutrient management practices. However, dry matter production has direct effect on yield and its accumulation. The higher dry matter content can be accomplished by plants only when there is a sound development of vegetative growth *viz.,* plant height and number of branches. The growth parameters recorded at different growth stages of crop were significantly higher with INM over other treatments. The beneficial effects of INM on growth, development and yield of various crops have been reported by several scientists. In this regard, Meena Nair and Peter (1990) reported that, the combination of fertilizers containing N at 125 or 175 kg/ha with FYM as INM approach, significantly increased the yield when compared with the organic or inorganic fertilizers applied alone.

Similar results were obtained by Hosmani *et al.* (1993), Sharu and Meerabai (2001) and Gopinath *et al.* (2008), while working with nutritional aspect of chilli.

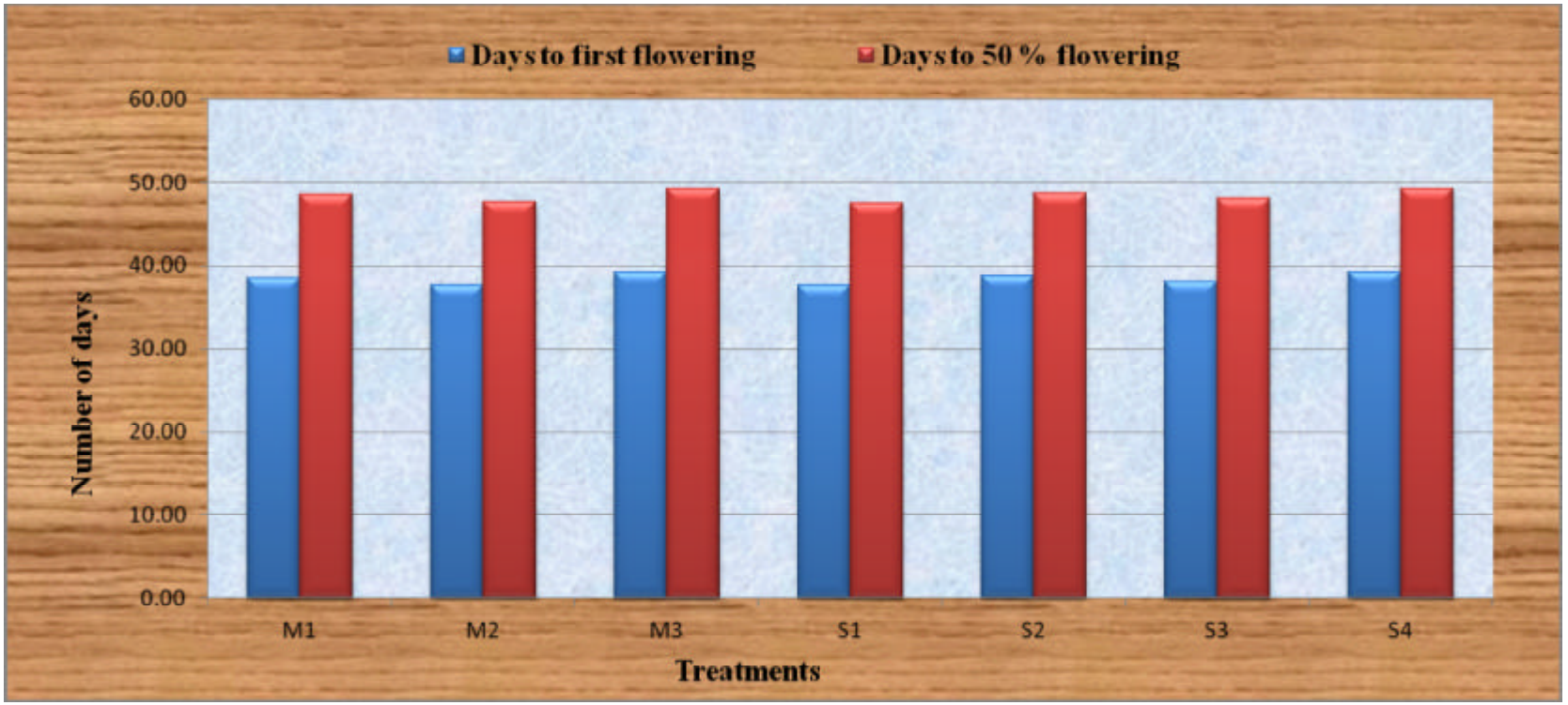

Fig. 2. Effect of nutrient management practices and organic amendments on days to first and 50 % flowering of chilli

M_1- Organic practice
M_2- INM practices (50 % organic + 50 % inorganic)
M_3-Inorganic practice

S_1-Panchagavya spray @ 3 % + *Verticillium luccani* at 30 and 60 DAT
S_2-Cow urine spray @ 10 % + *Verticillium luccani* at 30 and 60 DAT
S_3- Jeevamrut spray as it is + *Verticillium luccani* at 30 and 60 DAT
S_4- Control (water spray)

These scientists asserted that, the integration of both organics and inorganics bring significantly higher yield in the aforesaid crop. Subbiah *et al.* (1994) registered the highest total dry yield (5.65 t/ha) of chilli Cv. 'CO.1' when it was supplemented with 100 % recommended dose of NPK + biofertilizers.

Endorsing the views of above scientists, Patil and Biradar (2001) recorded the highest fruit yield of 19.12 q/ha with the application of 200 % RDF + FYM (10 t/ha) + Vermi compost (2.5 t/ha). Patil *et al.* (2004) reported that, application of FYM (50 %) along with half RDF recorded maximum number of fruits per plant and the highest fruit yield when compared to those plants which were fed with 100 % RDF. Kattimani *et al.* (2009) showed application of organics viz., Farm yard manure (FYM) along with 100 % RDF resulted in higher fruit yield of 919 kg/ha than RDF alone in chilli. Further, Surya kumari *et al.* (2009) also reported beneficial effect of integrated management of nutrients consists of vermi compost @ 5 t/ha + 150 % RDN, which showed the maximum weight of 100 fruits, higher fruit set and yield/ha. In conformity with above findings, several research workers reported positive impact of INM practices (Vikash kumar *et al* and Deshpande *et al.* in chilli; Malik *et al* in sweet pepper). While working on various aspects of nutrition, Leela Rani *et al.* (2015) confirmed that, combined application of 150 kg N/ha along with 10t FYM and 0.5 t neem cake/ha had significant increase in number of fruits per plant, yield per plant and total green chilli yield.

The enhanced yield due to adoption of INM practices was attributed to better growth and development of chilli plants as were better nourished with nutrients in an integrated manner. In this study also chilli plants were more vigorous (leaf area index, number of fruits per plant, fruit set %, dry matter content, average fruit weight and yield per plant) due to INM practice which might have helped chilli to produce more yield per unit area.

Among organic amendments panchagavya showed significantly higher yields compared to other amendments. These results are in conformity with the findings of Kondapanaidu (2009) who observed higher chilli yield, total dry matter production due to 50% RDN + 50% N through FYM +BF + Panchagavya. Similar results were also shared by Rao *et al.* (2014) who observed beneficial effect of panchagavya to enhance dry chilli yield, total dry matter production, number of fruits per plant.

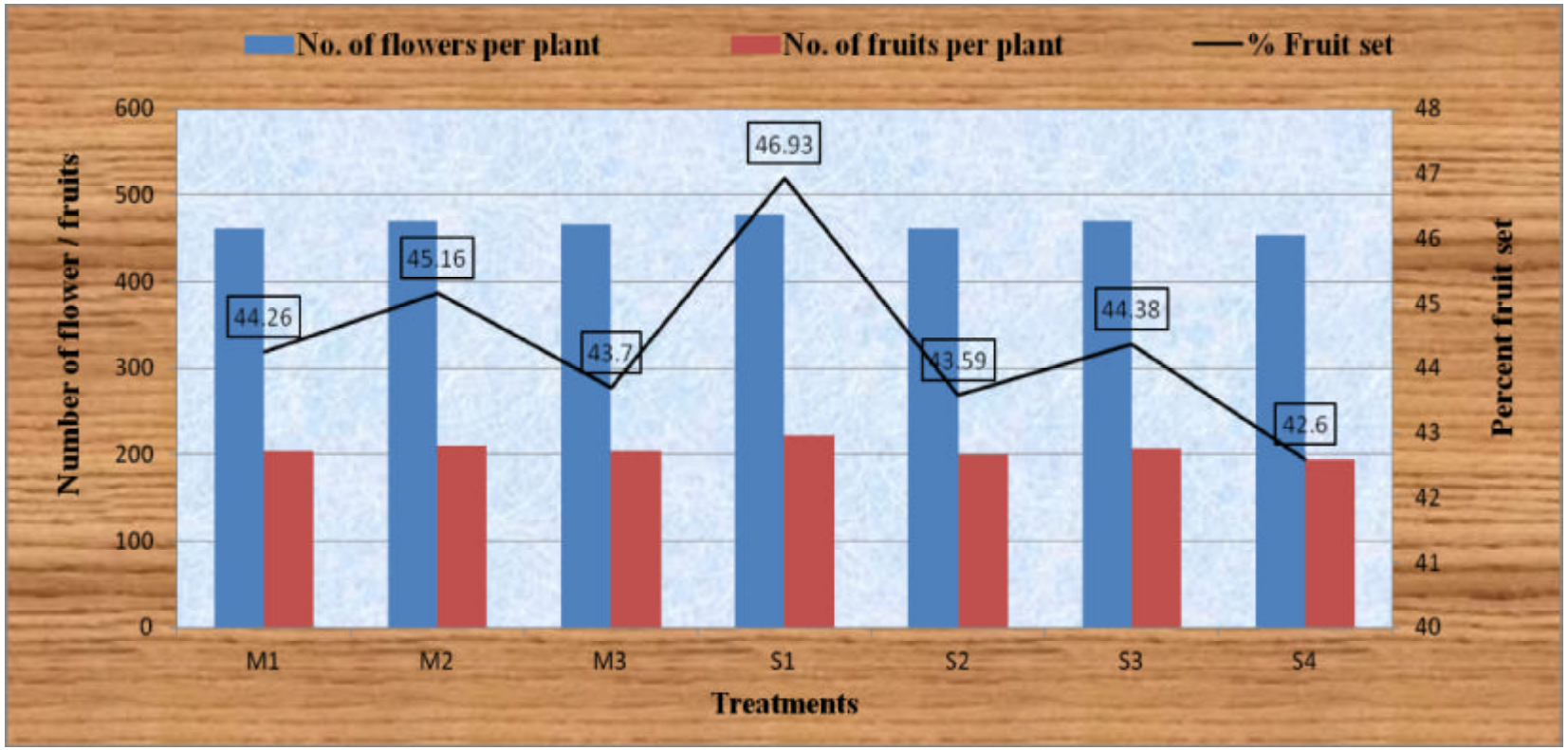

Fig. 3. Effect of nutrient management practices and organic amendments on number of flower and fruit per plant and % fruit set of chilli

M_1- Organic practice
M_2- INM practices (50 % organic + 50 % inorganic)
M_3-Inorganic practice

S_1-Panchagavya spray @ 3 % + Verticillium luccani at 30 and 60 DAT
S_2-Cow urine spray @ 10 % + Verticillium luccani at 30 and 60 DAT
S_3- Jeevamrut spray as it is + Verticillium luccani at 30 and 60 DAT
S_4- Control (water spray)

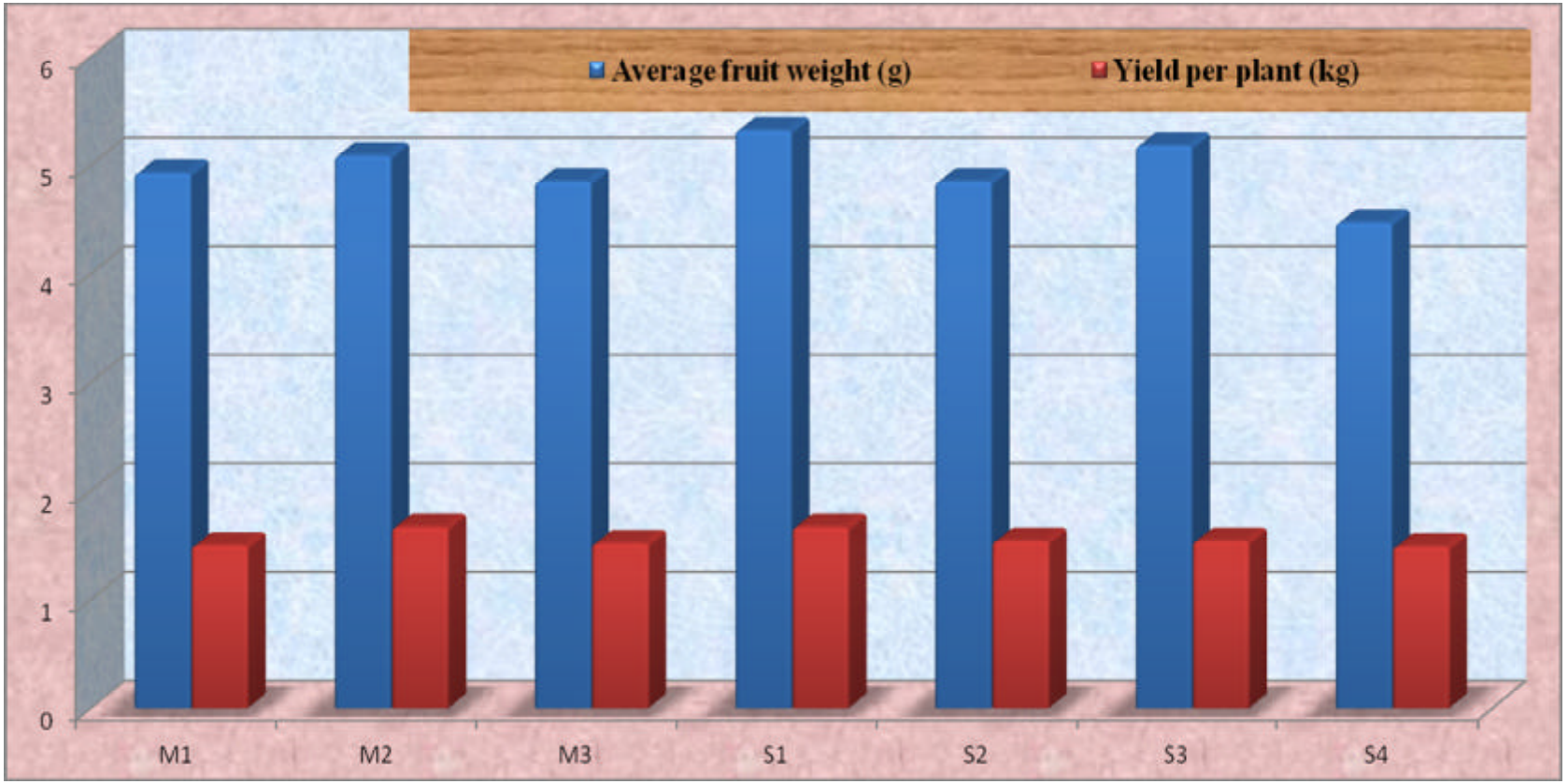

Fig. 4. Effect of nutrient management practices and organic amendments on average fruit weight and yield per plant of chilli

M_1- Organic practice
M_2- INM practices (50 % organic + 50 % inorganic)
M_3-Inorganic practice

S_1-Panchagavya spray @ 3 % + Verticillium luccani at 30 and 60 DAT
S_2-Cow urine spray @ 10 % + Verticillium luccani at 30 and 60 DAT
S_3- Jeevamrut spray as it is + Verticillium luccani at 30 and 60 DAT
S_4- Control (water spray)

It is non controversial fact that ultimate yield is the manifestation of yield attributing characters. Higher yield of chilli in the present investigation was governed by yield attributing components like number of fruits per plant, average fruit weight and yield per plant. In the present study, all the yield attributing parameters were significantly higher due to application of Panchagavya which is inherently rich in IAA, GA_3, major & micronutrients and also in beneficial microorganisms (Somasundaram, 2003). Hence, use of organic amendments (twice) in chilli might have stimulated the plant system and in turn increased the production of growth regulator in the cell system.

5.1.4 Quality parameters

The **c**hlorophyll content and ascorbic acid of chilli differed significantly by adopting different nutrient management practices and application of organic amendments. Significantly, the highest values were observed in chilli with regard to above characters when it was supplemented with organic nutrient management practices and panchagavya spray. Interaction effects were also proved to be highly significant. These results are in conformity with the findings of Pither and Hall (1990) and Nanthakumar and Veeragavatham (2001). They reported significantly higher ascorbic acid content with the application of organics. Naveen *et al.* (2009), while working with nutritional aspect and quality of green chilli reported higher ascorbic acid, capsaicin, oleoresin when chilli was supplemented with 100% organic manure which consisted of composted coir pith 25%+ Vermicompost 25%+ Bio-digested slurry 25%+ Azospirillum-PSB 25%. Further, Sreenivasa *et al.,* (2010) reported that the foliar application of panchagavya @ 3% at the time of flowering recorded higher ascorbic acid and capsaicin content in chilli fruits.

Both INM practice and panchagavya spray resulted in higher per cent dry matter in fruit, which in turn might have helped in enhancing the qualitative parameters of chilli. These results are similar to that of Thimma Naik (2006), who reported percent increase in oleoresin in the range of 2.3 to 13.89 per cent due to RDF and adoption of INM practices, respectively. Kondapanaidu *et al.* (2009) further asserted enhanced ascorbic acid content due to application of panchagavya. Naveen *et al.* (2009) witnessed higher moisture content in green chilli was by using organic manure.

The increase in ascorbic acid content might be ascribed to better availability and uptake of plant nutrients and also favourable conditions resulted by the applied FYM, which is known to help in the synthesis of chlorophyll and increased ascorbic acid content. This is quite evident from the study of Kaminwar and Rajagopal, 1993. Increase ascorbic acid content due to application of FYM or organic manures was also reported by Petkov (1964), Chavan *et al*. (1997) and Shashidhara (2000) in capsicum fruits and Patil *et al.* (2004) and Sable *et al.* (2007) in tomato.

5.2 Economics of different nutrient management practices and organic amendments on the performance of chilli

5.2.1 Economics

The acceptance of any technology developed to the farmers ultimately depends on the economics of the crop production. Among the different indicators of monitory efficiency, the economics in terms of net returns and B: C ratio has a greater impact on the practical utility and acceptance of technology.

In the present study, the gross returns, net returns and B: C ratio was significantly higher due to INM than organic and inorganic practice. The increase in net returns and B: C ratio with INM could be attributed to higher fruit yield of chilli and reduction in cost of cultivation. The adoption of organic practices resulted in comparatively less yield and resulted in the lowest net returns, on account of higher cost towards FYM. This problem can be overcome by encouraging production of organic manures on the farm itself. The present results are in accordance with those of Vimera *et al.* (2012) who estimated more profits/ha due to imposition of treatment consisting of 50% NPK + 50% FYM + biofertilizers (INM) as evident from highest net return. Endorsing the views of above scientist, Leela Rani *et al.* (2015) estimated high net income with the application of 150Kg nitrogen along with 10t FYM and 0.5 t neem cake/ha.

The estimated higher gross, net returns and B: C ratio was significantly higher with panchagavya spray than other amendments. The B: C ratio was more because of higher yield in panchagavya. These results are in line with those of Yadav and Christopher (2006) and Shwetha and Babalad (2008).

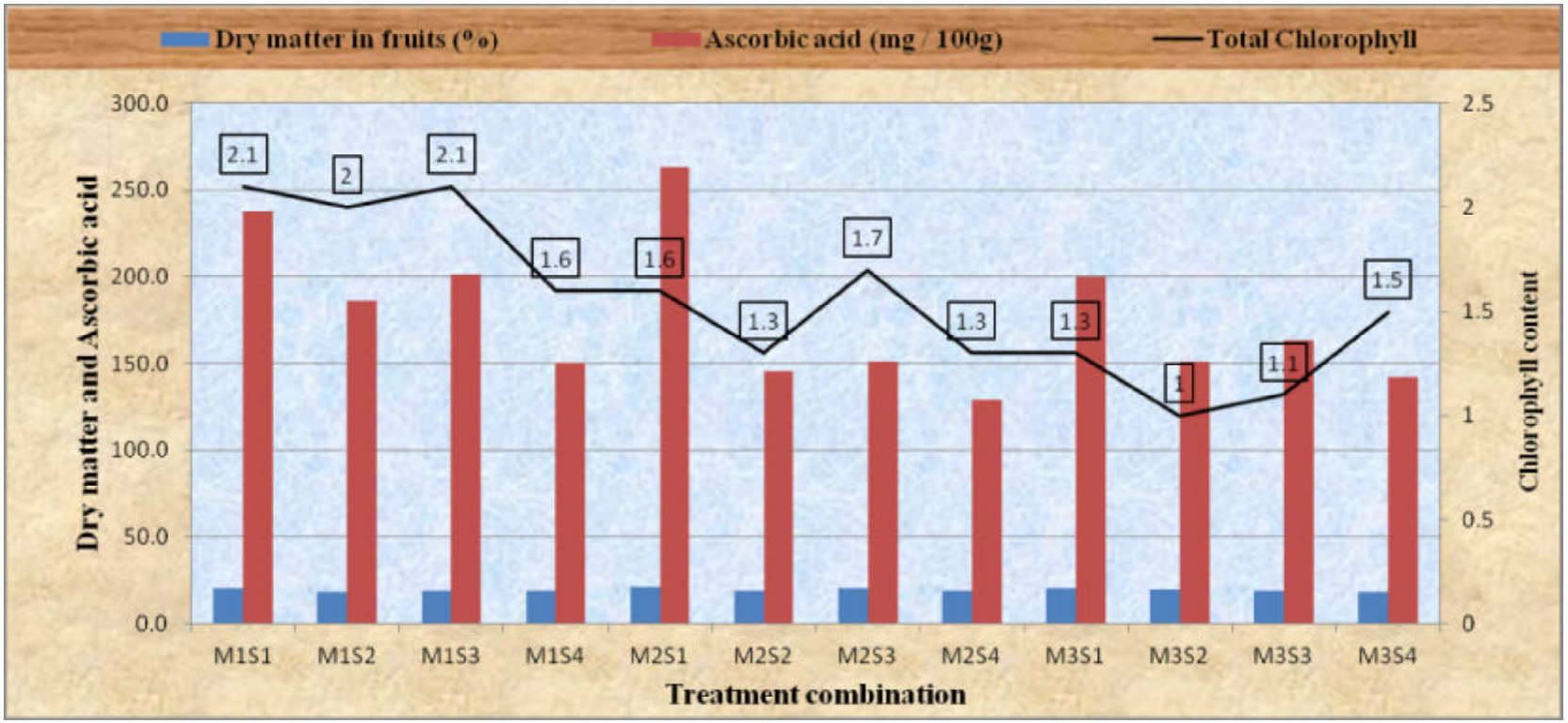

Fig. 5. Effect of nutrient management practices and organic amendments on dry matter in fruits, ascorbic acid content and total chlorophyll content of chilli

M_1- Organic practice
M_2- INM practices (50 % organic + 50 % inorganic)
M_3-Inorganic practice

S_1-Panchagavya spray @ 3 % + Verticillium luccani at 30 and 60 DAT
S_2-Cow urine spray @ 10 % + Verticillium luccani at 30 and 60 DAT
S_3- Jeevamrut spray as it is + Verticillium luccani at 30 and 60 DAT
S_4- Control (water spray)

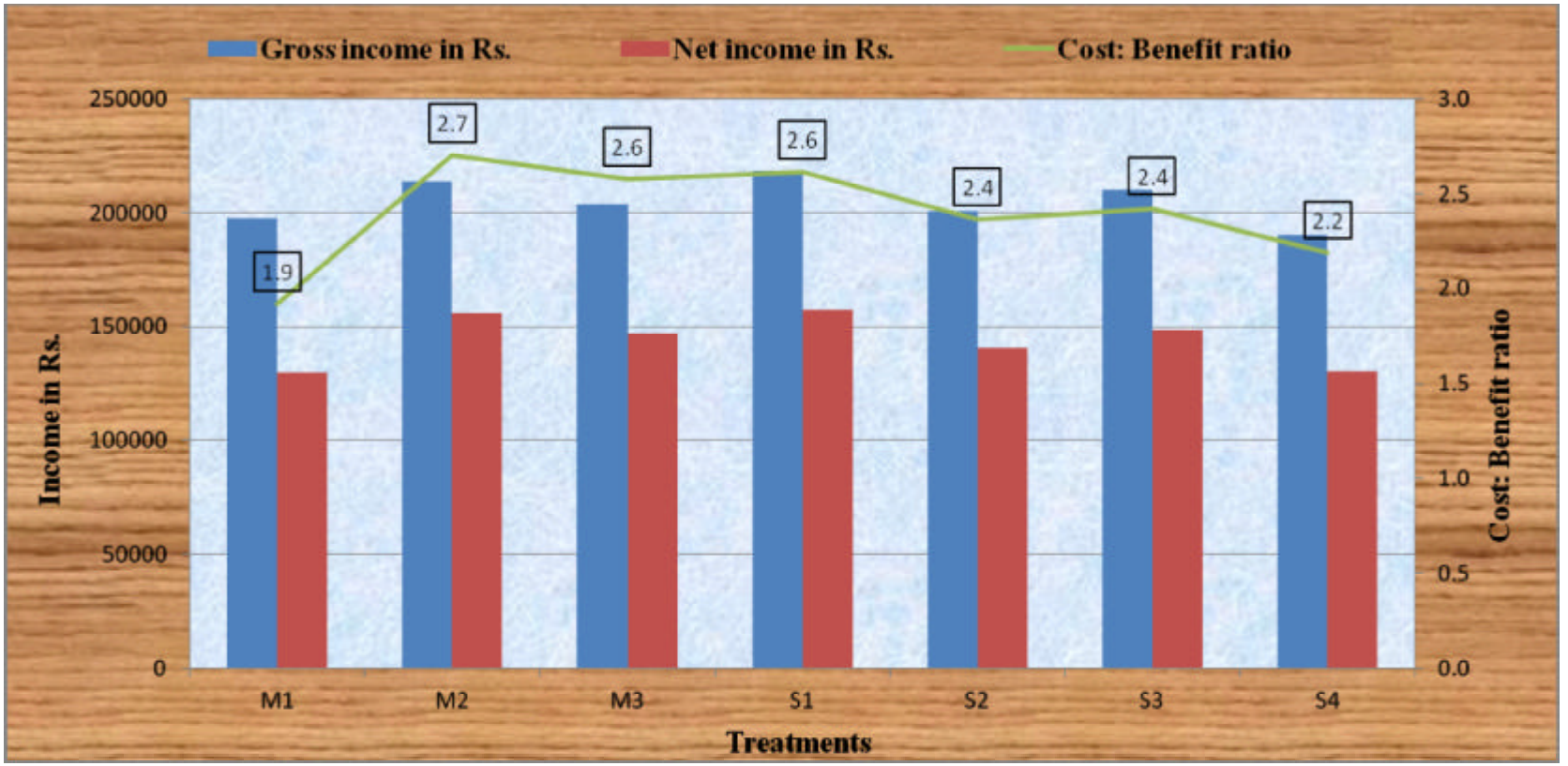

Fig. 6. Effect of nutrient management practices and organic amendments on economics of chilli

M_1- Organic practice
M_2- INM practices (50 % organic + 50 % inorganic)
M_3-Inorganic practice

S_1-Panchagavya spray @ 3 % + Verticillium luccani at 30 and 60 DAT
S_2-Cow urine spray @ 10 % + Verticillium luccani at 30 and 60 DAT
S_3- Jeevamrut spray as it is + Verticillium luccani at 30 and 60 DAT
S_4- Control (water spray)

Plate 2. Fruits of different treatment combination

Under aerable production system organic manures tend to release nutrients slowly for plant uptake at initial stages, may cause significant reduction in crop yield resulting lower farm income which can be overcome by the judicious use of chemical fertilizers to certain extent in combination with organic manures. It is perceived that the use of blend of FYM and organic amendments, lead to development ofa more synchronized nutrient supplementation system,which is known to maintain long term soil fertility and to sustain higher productivity of crops. Hence, an integration of fertilizers, organic manures and organic amendments provides an ideal nutrition for crops. However, chilli beinga crop of high nutrient demands needs heavy application of fertilizer to put forth good growth and higher yield.

Future line of work

1. There is a need to find out cheap and best method of organic manures preparation (composting) with high nutrient content.

2. A long term field investigations need to be conducted to ascertain the benefits of organic amendments on yield, quality and economics of chilli.

6. SUMMARY AND CONCLUSIONS

A field experiment was conducted at farmer field (Omanna), Neeralakatti village, Dharwad district, during 2015-16 to study the **Effect of soil test based INM practices on the performance of chilli**. The experiment consisted of two factors. Namely, Nutrient management practices [M_1-Supplementation of RDN through organic source; M_2-INM practices (50 % organic + 50 % RDN through inorganic); M_3-Inorganic practice] and Organic amendments [S_1-Panchagavya spray @ 3% at 30 and 60 DAT + *Verticillium luccani;* S_2-Cow urine spray @ 10% at 30 and 60 DAT + *Verticillium luccani;* S_3- Jeevamrut spray as it is at 30 and 60 DAT + *Verticillium luccani;* S_4- Control (water spray)]. The experiment was replicated thrice in a randomized complete block design with factorial concept. The salient findings of present investigation are summarized below.

The adoption of different nutrient management practices and organic amendments were studied on the performance of chilli. Among nutrient management practices, INM practice considered to be most beneficial as evident from higher yields obtained in chilli. Among organic amendments, panchagavya spray proved to be most beneficial as its application led to the better growth, higher yields. Interaction effect of nutrient management practices and organic amendments proved to be non-significant for most of the characters. However, INM with panchagavya resulted in better growth and development which is manifested in higher yields.

The quality parameters like ascorbic acid and chlorophyll were also influenced by both nutrient management practices and organic amendments. The combination of both organics and panchagavya proved to be most acceptable combination as exhibited in better quality chilli fruits. Further, dry matter content in fruits was more due to INM and panchagavya spray. The performance of crop has been much impressed, when it was raised with INM practices and application of organic amendments, when compared to adoption of either of these; further the impacts of which were reflected in all quality parameters.

Gross returns, net returns and B: C ratios were found significantly higher due to adoption of INM practice (213607 Rs, 155925 Rs. and 2:7) than others. Among organic amendments, use of panchagavya spray @ 3% + *Verticillium luccani* at 30

and 60 DAT (S_1) proved to be most productive as well as more economical; the usage of which results in higher gross returns (218600 Rs.), net returns (157600) and B:C ratio (2.6).

Conclusions

1. As the experiment was conducted for only one season, adoption of INM practices (M_2) was found superior over organics (M_1) and inorganic practices (M_3) as reflected in higher yields of chilli. Nevertheless, a significant increase in yield of chilli was recorded with the combined application of manures and organic amendments.

2. Adoption of organic practice and application of organic amendments resulted in high quality chilli fruits over other treatments.

3. Benefit: Cost ratio was more in chilli due to INM practice (2:7) and use of panchagavya (2:6).

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Appendix I: Bio-physical and chemical properties measured for study fields

Sl. No.	Particulars	Units	Method adopted
1	Soil type	Red	-
2	Clay %	13.93	-
3	Silt %	21.53	-
4	Fine sand %	33.77	-
5	Coarse sand %	30.77	-
6	OC (%)	0.65	-
7	pH	7.65	pH meter (Sparks, 1996)
8	EC	0.65	Conductivity bridge (Sparks, 1996)
9	Available Nitrogen (kg ha^{-1})	181.88	Alkaline potassium permanganate method (Subbaiah and Asija, 1956)
10	Available Phosphorus (kg ha^{-1})	70.78	Olsen's method, calorimetry (Jackson, 1973)
11	Available Potassium (kg ha^{-1})	149.7	Flame photometry (Jackson, 1973)

Appendix II: Weather data of Neeralakatti watershed management

Months	Temperature		Humidity	Rainfall
	Maximum	Minimum		
Aug – 2015	28.72	20.60	91.32	0.00
Sept -2015	29.90	20.57	93.26	33.00
Oct – 2015	31.20	19.56	77.00	465.0
Nov – 2015	30.03	18.19	83.63	28.6
Dec – 2015	30.64	15.71	76.03	0.00
Jan – 2016	30.05	14.24	58.80	0.40
Total	**30.09**	**18.14**	**80.00**	**527.00**

Appendix III: Pet hectare cost structure for chilli cultivation

Sl. No.	Particulars	Cost in Rs.		
		Organic practice	**INM practice**	**Inorganic practice**
1.	**Variable cost**			
A.	**Material cost**			
a.	Seeds	9000	9000	9000
b.	FYM	20000	10000	-
c.	Urea	-	1000	1800
d.	DAP	-	-	4500
e.	MOP	-	-	3000
f.	Panchagavya	900	900	900
g.	Jeevamrutha	1800	1800	1800
h.	Cow urine	30	30	30
i.	Plant protection chemicals	6000	6000	6000
j.	**Total material cost (A)**	**37730**	**28730**	**27030**
k.	Total labour cost (B)	10000	10000	10000
Total variable cost (C=A + B)		**47730**	**38730**	**37030**
2.	**Fixed cost**			
a.	Rental value of farm land	20000	20000	20000
b.	Interest on fixed capital @ 10%	2000	2000	2000
Total fixed cost (D)		**22000**	**22000**	**22000**
3.	**Total cost (C + D)**	**69730**	**60730**	**59030**

EFFECT OF SOIL TEST BASED INM PRACTICES ON THE PERFORMANCE OF CHILLI (*Capsicum annuum* L.)

RANJITHA B. M. **2016** **Dr. ALLOLLI T. B.**
Major Advisor

ABSTRACT

Experiment entitled "Effect of soil test based INM practices on the performance of Chilli (*Capsicum annuum* L.)" was carried out at farmer's field of Neeralakatti village, Dharwad (Karnataka) during *kharif* 2015. The experiment involving twelve different treatment combinations with water spray as control was laid out in randomized block design with factorial concept and replicated thrice to assess the performance of chilli for vegetative, earliness, yield and quality parameters. Analysis of variance revealed significant differences between the treatment combinations. INM found better for growth parameters (plant height, stem thickness, number of primary branches and number of secondary branches per plant), earliness (days to first and 50 % flowering) as well as yield parameters (number of flower and fruits per plant, per cent fruit set, average fruit weight, yield per plant and yield per plot) as reflected in vigorous plant and higher yield. Further INM was followed by inorganic practice. For quality traits like ascorbic acid content, per cent dry matter and chlorophyll content in fruits were found superior with organic practice, which was followed by INM practice.

Among different organic amendments panchagavya spray @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1) recorded significantly higher growth, earliness to flower, yield and quality parameters.

Gross returns, net returns and B: C ratios were found significantly higher due to adoption of INM practice (213607 Rs, 155925 Rs. and 2:7) than other nutrient management practices. Among organic amendments, use of panchagavya spray @ 3% + *Verticillium luccani* at 30 and 60 DAT (S_1) proved to be most productive as well as more economical; the usage of which results in higher gross returns (218600 Rs.), net returns (157600) and B:C ratio (2.6).

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