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# Growth, yield and quality parameters of chilli (*Capsicum annuum* L.) as influenced by application of different organic manures and decomposers

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**Abstract**
A field experiment was conducted at research and demonstration block of Research Institute on Organic Farming (RIOF), UAS, GKVK, Bengaluru during 2017-2018 to study the combined effect of different sources of organic manures and decomposers on growth, yield and quality parameters of Chilli fruits. The experiment was laid out on Factorial Randomized Block Design with 12 treatments and replicated thrice. Irrespective of the decomposers treatments, application of vermicompost on N equivalent basis had recorded significantly higher growth parameters *viz*., plant height, leaf area, leaf area index and total dry matter accumulation (82.76 and 87.37 cm at harvest, 868.68 and 903.97 $cm^2$ $plant^{-1}$ at 90 DAT, 1.45 and 1.51 at 90 DAT, 32.43 and 36.33 g $plant^{-1}$ at harvest during 2017 and 2018 season) and quality parameters *viz*., ascorbic acid, capsaicin content, oleoresin quantity and TSS content (120.89 and 125.28 mg 100 $g^{-1}$, 10.77 and 11.37 per cent, 63.56 and 66.86 per cent and 3.49 and 3.29 $^0$Brix) during 2017 and 2018 season of Chilli fruits as compared to application of FYM, poultry manure and sheep manure. Irrespective of organic manures treatments, jeevamrutha application had recorded significantly higher plant height (86.16 and 91.05 cm at harvest), leaf area (904 and 941.73 $cm^2$ $plant^{-1}$ at 90 DAT**)**, leaf area index (1.51 and 1.57 at 90 DAT), total dry matter accumulation (33.76 and 37.89 g $plant^{-1}$), ascorbic acid (124.26 and 129.08 mg 100 $g^{-1}$), capsaicin content (11.07 and 11.70 per cent), oleoresin quantity (65.46 and 69.66 per cent), TSS content (3.63 and 3.43 $^0$Brix), N content (2.08 and 2.13 per cent), P (0.35 and 0.39 per cent) content and K content (2.41 and 2.40 per cent) as compared to application of microbial consortia and NCOF-decomposer during both Seasion.

**Keywords:** Organic sources, jeevamrutha, decomposers, quality parameters, organic Chilli

## Introduction
Botanically Chilli (*Capsicum annum* L.) belongs to the family Solanaceae. It is an annual herb, profusely branching bushy plant. It is a rich source of vitamin C. Most of Indian Chilli belongs to the genus Capsicum, ad it is believed to have originated in the mountain ranges of Peru of South America. It was first introduced to India by Portuguese during the end of 15th century and now is widely distributed in all tropical and sub-tropical countries including India. India one of the largest producer, consumer and exporter of Chilli in the world, because of favorable soil and climatic conditions prevailing for Chilli production (Anon., 2011) [3]. After the green revolution, increase in production was achieved at the cost of soil health. The sustainable production at higher levels is possible only by the proper use of inputs which will help to increase the organic matter content of soils, thus reducing the bulk density and decreasing compaction. Various organic manures like farm yard manure, vermicompost, green manure etc., are added to the soil from time to time further added to the store of organic matter (Palaniappan and Annadurai, 1999) [31].

In organic farming nutrient are supplied through different sources of nutrients *viz*., FYM, vermicompost, poultry manure, and sheep manure etc. vermicompost is the casting from the earth worms produced by different species of *Eisenia fetida*, *Eudrilus eugeniae*, and *Perionyx excavates* etc. extensively used in vegetable production. Farm yard manure is a decomposed organic matter obtained by the action of microbial population in a warm and moist aerobic environment using cow dung, cow urine and other waste materials available from backyard cattle (Ramprasad *et al.*, 2009) [36].

Usage of liquid organic manures such as jeevamrutha, microbial consortia and decomposer results in increased growth and yield of crops and improve the soil physico-chemical and biological properties. They contain micro and macro nutrients, many vitamins, essential amino acids, beneficial microorganisms and growth promoting substances *viz*., IAA, GA (Devakumar *et al*., 2008 and Tharmaraj *et al*., 2011) [46]. Jeevamrutha is eco-friendly organic preparation made from cow products. The products from cow have the ability to bring the flow of cosmic energy which in turn can revitalize the growth process.

Chilli plants response well to inorganic fertilizers in terms of early vegetative growth but it decreased at later stage. Farmers nowadays keep on applying inorganic fertilizer for their crop as it can provide rapid nutrition but it will increase cost of production. Inorganic fertilizer is made up from synthetic materials, when excess of application, the soil will become toxic. Thus, this study intends to provide an alternative method by using several of organic treatment for enhancing growth, quality and NPK content of Chilli.

From this study, the best of organic treatment can be determined for optimum growth, quality and NPK content of Chilli. Farmers may use those treatments as an alternative ways in order to avoid excessive application of chemical fertilizer to the soil. Besides, farmers will have a proper management toward nutrients required for growth and completion of life cycle of the Chilli crop. Organic fertilizers may help farmer to increase soil structure, provide food source for soil micro-organisms, provides cation exchange capacity, increases water holding capacity, decrease toxicity at low pH and act as reservoir of plant nutrients (Zaccheo *et al*., 2002, Evanylo *et al*., 2008 and Mitchell *et al*., 2006) [26].

## Material and Methods

A field experiment was conducted at research and demonstration block of Research Institute on Organic Farming, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bengaluru which is situated in Eastern dry zone of Karnataka at a latitude of 12º 58′ North, longitude of 75º 35′ East and at an altitude of 930 m above mean sea level. The experiment was conducted to study the combined effect of different sources of organic manure, jeevamrutha and decomposers on growth and yield of Chilli during *kharif* - 2017 and 2018 under irrigated condition. The experiment was laid out on factorial Randomized Block Design with 12 treatments replicated thrice. The treatment are $T_1$: FYM x Jeevamrutha, $T_2$: FYM x Microbial consortia, $T_3$: FYM x Decomposer, $T_4$: Vermicompost x Jeevamrutha, $T_5$: Vermicompost x Microbial consortia, $T_6$: Vermicompost x Decomposer, $T_7$: Poultry manure x Jeevamrutha, $T_8$: Poultry manure x Microbial consortia, $T_9$: Poultry manure x Decomposer, $T_{10}$: Sheep manure x Jeevamrutha, $T_{11}$: Sheep manure x Microbial consortia and $T_{12}$: Sheep manure x Decomposer. Recommended dose of nutrients for chilli is 150:75:75 N: P2O5:K2O kg ha$^{-1}$ and nutrients were supplied through FYM, vermicompost, poultry manures and sheep manures on the basis of nitrogen equivalent. Treatment combinations consisted of four different organic sources ($M_1$: FYM, $M_2$: Vermicompost, $M_3$: Poultry Manure and $M_4$: Sheep manures-100% N equivalent basis), three decomposers (J: Jeevamrutha, C: Microbial consortia and N: decomposer developed by NCOF). Different sources of organic manure were incorporated into the soil, three weeks prior to planting. Application of jeevamrutha at 2000 l ha$^{-1}$, microbial consortia and NCOF- decomposer were applied at the time of planting and at different growth stages. Soil of the experimental site was red sandy loam with a pH of 6.93**,** EC (0.27 dSm$^{-1}$), low in organic carbon (0.44%) and medium in available nitrogen (292 kg ha$^{-1}$), $P_2O_5$ (27 kg ha$^{-1}$) and $K_2O$ (241 kg ha$^{-1}$).

### Preparation of Jeevamrutha

Jeevamrutha was prepared by mixing 10 kg cow dung, 10 litre cow urine, 2 kg jaggery, 2 kg pigeon pea flour and hand full of soil collected from farm. All these were put in 200 litres plastic drum and mixed thoroughly and volume was made up to 200 litres by adding water. The mixture was stirred well in clock wise direction thrice a day plastic drum was kept shade covered with wet jute bag. Jeevamrutha was fermented for 10 days and applied to the root zone of Chilli plants manually at of 20, 40, 60 and 80 days after transplanting (DAT) as per treatments (Devakumar *et al*., 2008 and Palekar, 2006) [31].

Experimental data collected was subjected to statistical analysis by adopting Fisher's method of analysis of variance (ANOVA) as outlined in Gomez and Gomez (1984) [21]. Critical difference (CD) values were calculated whenever the "F" test was significant at 5 per cent level.

## Results and Discussion

### Growth and Yield Effect of different sources of organic manures on growth and yield of Chilli

Among the different sources of application of organic manures like, FYM, vermicompost, poultry manure and sheep manure, application of vermicompost showed significantly higher growth and yield attributes of Chilli. Growth parameters differed significantly due to treatments effect at all the stages of crop growth except at 30 DAT. Irrespective of decomposers treatment, application of vermicompost on N equivalent basis through vermicompost recorded significantly higher growth parameters *viz.*, plant height, number of branches per plant, leaf area, leaf area index and total dry matter accumulation (82.76 and 87.37 cm at harvest, 28.92 and 32.33 at harvest, 868.68 and 903.97 cm$^2$ plant$^{-1}$ at 90 DAT, 1.45 and 1.51 at 90 DAT, 32.43 and 36.33 g plant$^{-1}$ at harvest during 2017 and 2018 season respectively), as compared to application of FYM on N equivalent basis through FYM. However, it was at par with the application of poultry manure on N equivalent basis *i.e.*, plant height, number of branches per plant, leaf area, leaf area index and total dry matter accumulation (78.43 and 82.69 cm at harvest, 27.40 and 30.56 at harvest, 856.17 and 823.69 cm$^2$ plant$^{-1}$ at 90 DAT, 1.37 and 1.43 at 90 DAT, 30.73 and 34.34 g plant$^{-1}$ at harvest during 2017 and 2018 season respectively), (Table I, II, III, IV, and Fig. 1 and 2). Similarly, fruit yield (20.47 and 23.09 t ha$^{-1}$) and stalk yield (5.28 and 6.15 t ha$^{-1}$) were recorded significantly higher with application of vermicompost *i.e.*, 100 per cent N equivalent as compared to FYM application *i.e.*100 per cent N equivalent (20.54 t ha$^{-1}$, 4.74 and 5.50 t ha$^{-1}$, respectively). It was at par with the application of poultry manure on N equivalent basis through poultry manure application (19.40 and 21.8 5 t ha$^{-1}$, 5.01and 5.83 t ha$^{-1}$, respectively) Table V.

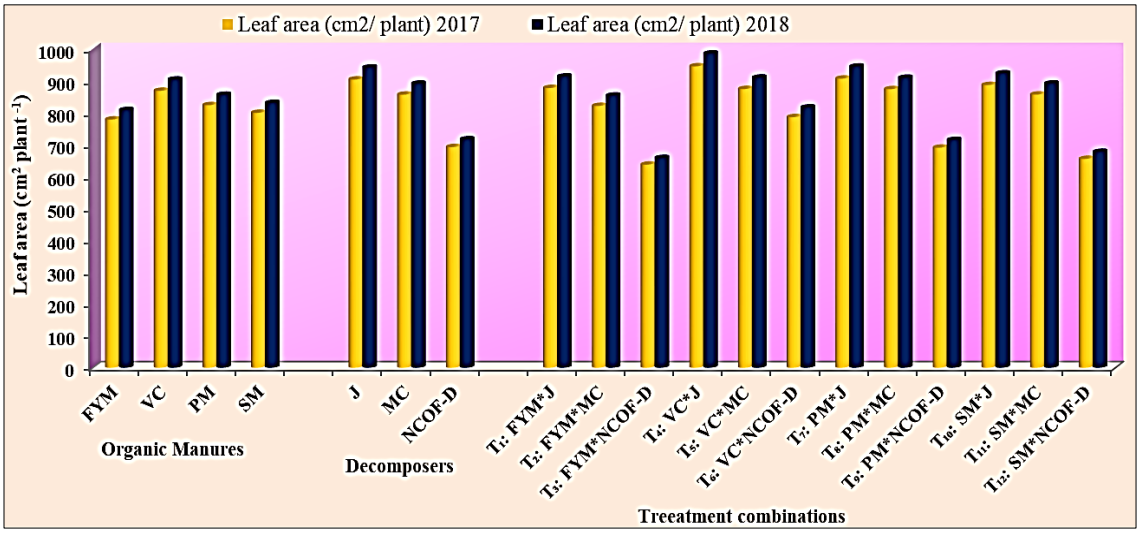
Significantly difference in growth parameters *viz*., plant height, number of branches per plant, leaf area, leaf area index and total dry matter production of chilli per hectare was noticed due to the application of vermicompost this might be due to vermicompost contains significant quantities of water soluble nutrients which are readily available to the crop during active growth periods. A large beneficial microbial population like, bacteria, Protozoa, nematodes, fungi, actinomycetes are present in Vermicompost. In terms of plant

growth and soil health, vermicompost plays an important role in improving soil texture, aeration, soil compaction and thus enhances more water and nutrients uptake by plants from their surrounding areas of root zone.

As regard to the direct effect on plant growth, vermicompost constitutes a source of plant macro- and micronutrients. Although some of these nutrients are present in inorganic form and are available to plants, most of them are released gradually through mineralization of organic matter, thus constituting slow release fertilizer that supplies the plant with a gradual and constant source of nutrients (Chaoui *et al.* 2003). However, the amount of nutrients provided may vary greatly depending on the original feedstock, processing time and maturity of the vermicompost (Campitelli and Ceppi, 2008). The present results are in accordance with the earlier studies carried out by Pritam *et al.* (2010) [33]. Vermicompost having hormone-like activity aids in greater root initiation, increased root biomass resulting in enhanced plant growth. Optimum plant growth and development is important for greater final dry matter and yields. In order to achieve this, sufficient amounts of nutrients should be applied to the soil through organic sources. Vermicompost, an organic source of plant nutrients, contains higher percentage of nutrients for plant growth in readily available form (Nagavallemma *et al.*, 2004) [27].

Increased yield might be due to higher yield parameters and total dry matter accumulation (TDMA) with application of vermicompost as compare to other organic manures. This might be due to taller plants which resulted in more number of branches per plant, more leaf area and more leaf area index. This might be due to higher and readily availability of water soluble nutrient present in the vermicompost and in addition to this vermicompost releases nutrient slowly and provide nutrient throughout the growth period. These results are in conformity with findings of Husain *et al*. (2014), Anand and Gupta (2018) [2], Chandan singh and Azad Husain (2015), Adekiya *et al*. (2017) [1]. Similarly, the significantly increased in yield parameters of chilli was observed with application of vermicompost may be due to release of $NO_3^{-2}$ and $NH4^+$ form of nitrogen was higher with the application of vermicompost as compared to other organic fertilizer like FYM, poultry manure and sheep manure this might be due to the narrow C: N ratio of vermicompost (Velmurgan and Swarnam 2013) [50]. This might have facilitated in release of plant nutrients to labile nutrient pool thereby more availability of nutrients to plants. These results also in conformity with results recorded by Hangarge *et al*. (2001) [22] and Shashidhara and Shivamurthy (2008) [40] reported that maximum growth parameters in chilli were recorded under integrated nutrient supply system (RDF and vermicompost application). Further these results are in conformity with the findings of Chumyani *et al*. (2012) [16] in tomato, and Chumei *et al*. (2013) [15] in brinjal, who found maximum growth characters under integrated nutrient supply system.

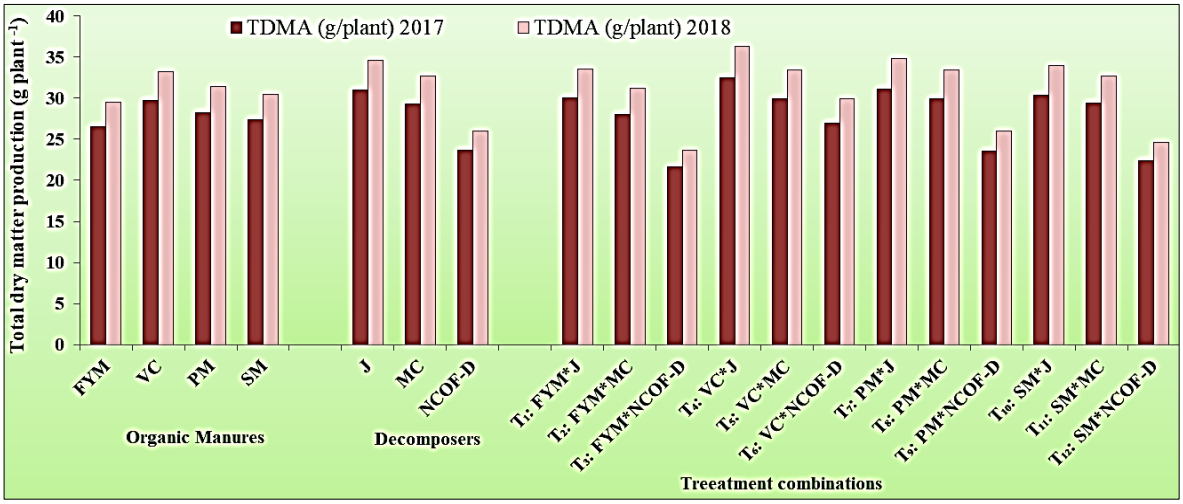
The lower yield recorded with FYM might be due to wider C: N ratio than vermicompost. Out of 100 per cent FYM application to the field only 1/3rd portion of the nutrient is available to the first session and remaining portion of nutrient is available to the succeeding crop. Therefore during first season crop their might be a shortage of nutrients resulting lower in growth and yield parameters. Application of FYM increases the aeration, organic matter content, water holding capacity and nutrient status of the soil and result in better growth during the succeeding crops.




Factor - I: Organic sources
FYM – Farm Yard Manure
VC – Vermicompost
PM – Poultry manure
SM – Sheep manure

Factor - II: Decomposers
J – Jeevamrutha
C – Microbial consortia
NCOF-D– Decomposer from NCOF

**Fig 1:** Leaf area at 135 DAT of chilli as influenced by application of organic manures, jeevamrutha and decomposers during *kharif* 2017 and 2018

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FYM – Farm Yard Manure
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Factor - II: Decomposers
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NCOF-D– Decomposer from NCOF

**Fig 2:** Total dry matter production of chilli at harvest as influenced by application of organic manures, jeevamrutha and decomposers during *kharif* 2017 and 2018

**Effect of decomposers on growth and yield Chilli**

Among the different sources of application of decomposers like, jeevamrutha, microbial consortia and decomposers. Application of jeevamrutha showed significant effect on growth and yield attributes of chilli. Further, increase in plant height (86.16 and 91.05 cm at harvest), number of branches (30.10 and 33.72) and more leaf area (904.22 and 941.73 $cm^2$ $plant^{-1}$ at 90 DAT) might be due to application of jeevamrutha at 2000 l $ha^{-1}$. The jeevamrutha application might have shown higher foliage with dark green coloured leaves indicating rich chlorophyll content might be responsible for production of more photosynthates and translocation to the vegetative buds and fruits. This is in accordance with findings of Yadav and Mowade (2004) [52], Siddaram (2012) [43] and who have reported application of liquid manures such as jeevamrutha and biodigester liquid manures have increased yield in rice and other crops. Application of jeevamrutha might have helped in greater availability of nutrients in the rhizosphere soil has enhanced the uptake of nitrogen, total phosphorus and total potassium than microbial consortia and NCOF-decomposer during 2017 and 2018. These findings are in accordance with Reshma Sutar *et al*., (2017) and they reported that significantly higher uptake of nitrogen, phosphorus and potassium was recorded with the application of jeevamrutha at 1000 l $ha^{-1}$. Jeevamrutha is an important organic liquid formulation which provides a congenial environment to microorganisms upon its application to soil which helps in making essential nutrients available for plant growth *viz*., nitrogen, phosphorus and potassium to the plants and providing congenial environment to beneficial microbes (Devakumar *et al*. 2008) [17]. Jeevamrutha also contains enormous amount of microbial load which multiply and act as a soil tonic. It is said to enhance microbial activity in soil and ultimately ensuring the availability and uptake of nutrients by the crops (Devaumar *et al*., 2008 and Srinivasa *et al*., 2009).

Significantly higher green chilli yield (21.31 and 24.06 t $ha^{-1}$) was recorded with the application of jeevamrutha at 2000 l $ha^{-1}$ as compared to microbial consortia (20.17 and 22.74 t ha-1) and decomposer (16.24 and 18.20 t $ha^{-1}$) and it was 23.79 and 24.35 per cent increase in yield with application of jeevamrutha during both the seasons. These results are in conformity with the findings of Vishwajith *et al*. (2018) in okra, Reshma Sutar *et al*. (2018) [32] in cowpea, Naveena (2017) [28] in ragi, Rekha Gonal (2017) [37] in baby corn, Basavaraj Kumbar *et al*. (2017) [6] in french bean. The increase in yield might be due to significant increase in yield parameters such as higher number of fruits, fruit length and fruit weight (Table 7). These results are in line with Somasundaram (2003) [44] in maize-sunflower-greengram system, Boomiraj (2003) [10] in bhendi and Yadav and Lourduraj (2006) [53] in rice. Boraiah *et al*. (2017) [11] in capsicum and they reported that application of jeevamrutha resulted in 7.98 to 26.20 per cent increase in fruit yield of chilli as compared to without jeevamrutha application.

Significantly higher number of growth components and yield components in jeevamrutha was due to higher amount of nutrient content like nitrogen, phosphorus and potassium (1.96%, 0.280% and 0.173%, respectively) and also contains Mg (46 ppm) and Cu (51 ppm) and maximum microbial population (maximum CFU of bacteria (855), fungi (29), actinomycets (8), N-fixers (69) and P-solubilizer (80) was observed in jeevamrutha (Devakumar *et al*. 2008 and 2014). This might have enhanced the decomposition process in the soil which might have resulted in relatively quick release of nutrients from compost than without application of jeevamrutha. The higher growth parameters were also due to the supply of micro nutrients, vitamins, essential amino acids and growth promoting substances like Indole Acetic Acid (IAA), Gibberlic Acid (GA) and beneficial microorganisms, Palekar (2006) [31]; Sreenivas *et al*., (2011) [29]; Neelima and Sreenivas, (2011) [29]. It is said to enhance microbial activity in soil and ultimately ensuring the availability and uptake of nutrients by the crops. These results are in consonance with findings of Siddappa (2015) [42] in field bean, Basavaraj Kumbar (2016) in frenchbean, Basavaraj kumbar and Devakumar (2016). Siddappa *et al*., (2017) [41] reported that significantly higher growth and yield parameters were recorded in application of jeevamrutha at 1500 L $ha^{-1}$ over 1000 and 500 L $ha^{-1}$ in fieldbean.

**Interaction effect of different sources of organic manures and decomposer on growth and yield of Chilli**

Interaction effect among different sources of organic manure and decomposers was found to be observed. Numerically higher and lower fruit yield (22.30 and 14.85 t $ha^{-1}$, respectively) and stalk yield (5.75 and 3.87 t $ha^{-1}$, respectively) were observed in the treatment combined application of vermicompost and jeevamrutha and FYM and decomposers respectively.

From this study it can be concluded that application of different sources of organic manure (FYM, vermicompost, poultry manure and sheep manure) and liquid organic manures (jeevamrutha microbial consortia and decomposer) are beneficial in improving growth and yield of chilli by providing better availability of nutrients, improved microbial activity and availability of growth promoting substances.

**Table 1:** Plant height of chilli as influenced by application of organic manures, jeevamrutha and decomposers during *kharif 2017*

| Manures | Plant height (cm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 30 DAT | | | | 60 DAT | | | |
| | Decomposers | | | | Decomposers | | | |
| | J | C | N | Mean | J | C | N | Mean |
| FYM | 29.87 | 28.72 | 27.80 | 28.79 | 51.04 | 47.69 | 36.69 | 45.14 |
| VC | 30.95 | 29.59 | 28.51 | 29.68 | 55.10 | 50.92 | 45.72 | 50.58 |
| PM | 30.74 | 29.27 | 28.29 | 29.43 | 52.83 | 50.89 | 40.08 | 47.93 |
| SM | 30.48 | 28.86 | 28.12 | 29.15 | 51.65 | 49.89 | 38.02 | 46.52 |
| Mean | 30.51 | 29.11 | 28.18 | | 52.66 | 49.84 | 40.13 | |
| | S. Em ± | | CD (P = 0.05) | | S. Em ± | | CD (P = 0.05) | |
| M | 0.780 | | NS | | 0.941 | | 2.761 | |
| D | 0.778 | | NS | | 0.815 | | 2.391 | |
| M x D | 1.351 | | NS | | 1.631 | | NS | |
| Manures | Plant height (cm) | | | | | | | |
| | 90 DAT | | | | At harvest | | | |
| | Decomposers | | | | Decomposers | | | |
| | J | C | N | Mean | J | C | N | Mean |
| FYM | 71.15 | 66.59 | 51.66 | 63.13 | 83.52 | 78.03 | 60.03 | 73.86 |
| VC | 76.66 | 70.89 | 63.74 | 70.43 | 90.16 | 83.31 | 74.82 | 82.76 |
| PM | 73.54 | 70.85 | 55.96 | 66.78 | 86.45 | 83.26 | 65.58 | 78.43 |
| SM | 71.90 | 69.48 | 53.12 | 64.83 | 84.51 | 81.63 | 62.21 | 76.12 |
| Mean | 73.31 | 69.45 | 56.12 | | 86.16 | 81.56 | 65.66 | |
| | S. Em ± | | CD (P = 0.05) | | S. Em ± | | CD (P = 0.05) | |
| M | 1.757 | | 5.153 | | 2.062 | | 6.047 | |
| D | 1.522 | | 4.462 | | 1.786 | | 5.237 | |
| M x D | 3.043 | | NS | | 3.571 | | NS | |

CD at 5% NS - Non-Significant DAT- Days after Transplanting M - Manures
RDF: 125:75:63 kg N: P2O5:K2O $ha^{-1}$ for N equivalent FYM application D - Decomposers
FYM - Farm yard manure VC - Vermicompost PM - Poultry manure SM - Sheep manure
J - Jeevamrutha C - Microbial Consortia N - Decomposer from NCOF

**Table 2:** Plant height of Chilli as influenced by application of organic manures, jeevamrutha and decomposers during *kharif* 2018

| Manures | Plant height (cm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 30 DAT | | | | 60 DAT | | | |
| | Decomposers | | | | Decomposers | | | |
| | J | C | N | Mean | J | C | N | Mean |
| FYM | 31.57 | 30.42 | 29.50 | 30.50 | 54.35 | 50.73 | 38.87 | 47.98 |
| VC | 32.64 | 31.32 | 29.73 | 31.23 | 58.73 | 54.22 | 48.61 | 53.85 |
| PM | 32.39 | 30.81 | 29.56 | 30.92 | 56.28 | 54.18 | 42.53 | 51.00 |
| SM | 32.09 | 30.20 | 29.14 | 30.48 | 55.01 | 53.11 | 40.30 | 49.47 |
| Mean | 32.18 | 30.69 | 29.48 | | 56.09 | 53.06 | 42.58 | |
| | S. Em ± | | CD (P = 0.05) | | S. Em ± | | CD (P = 0.05) | |
| M | 0.858 | | NS | | 1.031 | | 3.022 | |
| D | 0.743 | | NS | | 0.892 | | 2.618 | |
| M x D | 1.486 | | NS | | 1.785 | | NS | |
| Manures | Plant height (cm) | | | | | | | |
| | 90 DAT | | | | At harvest | | | |
| | Decomposers | | | | Decomposers | | | |
| | J | C | N | Mean | J | C | N | Mean |
| FYM | 73.41 | 68.65 | 53.07 | 65.04 | 88.19 | 82.25 | 62.78 | 77.74 |
| VC | 79.15 | 73.14 | 65.68 | 72.66 | 95.38 | 87.97 | 78.78 | 87.37 |
| PM | 75.89 | 73.09 | 57.57 | 68.85 | 91.36 | 87.91 | 68.79 | 82.69 |
| SM | 74.19 | 71.66 | 54.61 | 66.82 | 89.27 | 86.15 | 65.14 | 80.18 |
| Mean | 75.66 | 71.64 | 57.73 | | 91.05 | 86.07 | 68.87 | |
| | S. Em ± | | CD (P = 0.05) | | S. Em ± | | CD (P = 0.05) | |
| M | 1.359 | | 3.985 | | 1.635 | | 4.796 | |

| | | | | |
|---|---|---|---|---|
| D | 1.177 | 3.451 | 1.416 | 4.153 |
| M x D | 2.353 | NS | 2.832 | NS |

CD at 5% NS - Non-Significant DAT- Days after Transplanting M - Manures
RDF: 125:75:63 kg N: P2O5:K2O ha$^{-1}$ for N equivalent FYM application D - Decomposers
FYM - Farm yard manure VC - Vermicompost PM - Poultry manure SM - Sheep manure
J - Jeevamrutha C - Microbial Consortia N - Decomposer from NCOF

**Table 3:** Leaf area index of chilli as influenced by application of organic manures, jeevamrutha and decomposers during *kharif* 2017

| Manures | Leaf area index plant$^{-1}$ | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 30 DAT | | | | 60 DAT | | | |
| | Decomposers | | | | Decomposers | | | |
| | J | C | N | Mean | J | C | N | Mean |
| FYM | 0.53 | 0.37 | 0.51 | 0.47 | 0.70 | 0.66 | 0.51 | 0.62 |
| VC | 0.55 | 0.57 | 0.53 | 0.55 | 0.76 | 0.70 | 0.63 | 0.70 |
| PM | 0.54 | 0.57 | 0.52 | 0.54 | 0.73 | 0.70 | 0.55 | 0.66 |
| SM | 0.53 | 0.56 | 0.52 | 0.54 | 0.71 | 0.69 | 0.52 | 0.64 |
| Mean | 0.54 | 0.52 | 0.52 | | 0.73 | 0.69 | 0.55 | |
| | S. Em ± | | CD (P = 0.05) | | S. Em ± | | CD (P = 0.05) | |
| M | 0.014 | | NS | | 0.017 | | 0.014 | |
| D | 0.012 | | NS | | 0.015 | | 0.012 | |
| M x D | 0.024 | | NS | | 0.030 | | NS | |
| Manures | Leaf area index plant$^{-1}$ | | | | | | | |
| | 90 DAT | | | | At harvest | | | |
| | Decomposers | | | | Decomposers | | | |
| | J | C | N | Mean | J | C | N | Mean |
| FYM | 1.46 | 1.37 | 1.06 | 1.30 | 1.31 | 1.23 | 0.94 | 1.16 |
| VC | 1.58 | 1.46 | 1.31 | 1.45 | 1.42 | 1.31 | 1.18 | 1.30 |
| PM | 1.51 | 1.46 | 1.15 | 1.37 | 1.36 | 1.31 | 1.03 | 1.23 |
| SM | 1.48 | 1.43 | 1.09 | 1.33 | 1.33 | 1.28 | 0.98 | 1.20 |
| Mean | 1.51 | 1.43 | 1.15 | | 1.35 | 1.28 | 1.03 | |
| | S. Em ± | | CD (P = 0.05) | | S. Em ± | | CD (P = 0.05) | |
| M | 0.036 | | 0.106 | | 0.032 | | 0.095 | |
| D | 0.031 | | 0.092 | | 0.028 | | 0.082 | |
| M x D | 0.063 | | NS | | 0.056 | | NS | |

CD at 5% NS - Non-Significant DAT- Days after Transplanting M - Manures
RDF: 125:75:63 kg N: P2O5:K2O ha$^{-1}$ for N equivalent FYM application D - Decomposers
FYM - Farm yard manure VC - Vermicompost PM - Poultry manure SM - Sheep manure
J - Jeevamrutha C - Microbial Consortia N - Decomposer from NCOF

**Table 4:** Leaf area index of Chilli as influenced by application of organic manures, Jeevamrutha and decomposers during *kharif* 2018

| Manures | Leaf area index plant$^{-1}$ | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 30 DAT | | | | 60 DAT | | | |
| | Decomposers | | | | Decomposers | | | |
| | J | C | N | Mean | J | C | N | Mean |
| FYM | 0.69 | 0.65 | 0.63 | 0.65 | 0.84 | 0.78 | 0.60 | 0.74 |
| VC | 0.71 | 0.67 | 0.66 | 0.68 | 0.91 | 0.84 | 0.75 | 0.83 |
| PM | 0.70 | 0.67 | 0.64 | 0.67 | 0.87 | 0.83 | 0.65 | 0.79 |
| SM | 0.70 | 0.66 | 0.63 | 0.66 | 0.85 | 0.82 | 0.62 | 0.76 |
| Mean | 0.70 | 0.66 | 0.64 | | 0.86 | 0.82 | 0.65 | |
| | S. Em ± | | CD (P = 0.05) | | S. Em ± | | CD (P = 0.05) | |
| M | 0.019 | | NS | | 0.021 | | 0.063 | |
| D | 0.016 | | NS | | 0.019 | | 0.054 | |
| M x D | 0.032 | | NS | | 0.037 | | NS | |
| Manures | Leaf area index plant$^{-1}$ | | | | | | | |
| | 90 DAT | | | | At harvest | | | |
| | Decomposers | | | | Decomposers | | | |
| | J | C | N | Mean | J | C | N | Mean |
| FYM | 1.52 | 1.42 | 1.10 | 1.35 | 1.37 | 1.27 | 0.97 | 1.20 |
| VC | 1.64 | 1.52 | 1.36 | 1.51 | 1.48 | 1.37 | 1.22 | 1.36 |
| PM | 1.57 | 1.52 | 1.19 | 1.43 | 1.42 | 1.36 | 1.06 | 1.28 |
| SM | 1.54 | 1.49 | 1.13 | 1.38 | 1.39 | 1.34 | 1.00 | 1.24 |
| Mean | 1.57 | 1.49 | 1.19 | | 1.41 | 1.34 | 1.06 | |
| | S. Em ± | | CD (P = 0.05) | | S. Em ± | | CD (P = 0.05) | |
| M | 0.039 | | 0.114 | | 0.035 | | 0.103 | |
| D | 0.034 | | 0.099 | | 0.030 | | 0.089 | |
| M x D | 0.068 | | NS | | 0.061 | | NS | |

CD at 5% NS - Non-Significant DAT- Days after Transplanting M - Manures
RDF: 125:75:63 kg N: P2O5:K2O ha$^{-1}$ for N equivalent FYM application D - Decomposers
FYM - Farm yard manure VC - Vermicompost PM - Poultry manure SM - Sheep manure
J – Jeevamrutha C - Microbial Consortia N - Decomposer from NCOF

**Table 5:** Green chilli yield and stalk yield of chilli as influenced by application of organic manures, jeevamrutha and decomposers during *kharif 2017* and 2018

| Manures | Green Chilli yield (t ha$^{-1}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2017 | | | | 2018 | | | |
| | Decomposers | | | | Decomposers | | | |
| | J | C | N | Mean | J | C | N | Mean |
| FYM | 20.66 | 19.30 | 14.85 | 18.27 | 23.30 | 21.73 | 16.59 | 20.54 |
| VC | 22.30 | 20.61 | 18.51 | 20.47 | 25.20 | 23.24 | 20.81 | 23.09 |
| PM | 21.38 | 20.59 | 16.22 | 19.40 | 24.14 | 23.23 | 18.17 | 21.85 |
| SM | 20.90 | 20.19 | 15.39 | 18.83 | 23.59 | 22.76 | 17.21 | 21.19 |
| Mean | 21.31 | 20.17 | 16.24 | | 24.06 | 22.74 | 18.20 | |
| | S. Em ± | | CD (P = 0.05) | | S. Em ± | | CD (P = 0.05) | |
| M | 0.510 | | 1.496 | | 0.596 | | 1.749 | |
| D | 0.442 | | 1.295 | | 0.516 | | 1.514 | |
| M x D | 0.883 | | NS | | 1.033 | | NS | |
| **Manures** | **Stalk yield (t ha$^{-1}$)** | | | | | | | |
| | 2017 | | | | 2018 | | | |
| | Decomposers | | | | Decomposers | | | |
| | J | C | N | Mean | J | C | N | Mean |
| FYM | 5.34 | 4.99 | 3.87 | 4.74 | 6.22 | 5.81 | 4.48 | 5.50 |
| VC | 5.75 | 5.32 | 4.78 | 5.28 | 6.71 | 6.20 | 5.56 | 6.15 |
| PM | 5.52 | 5.31 | 4.20 | 5.01 | 6.43 | 6.19 | 4.86 | 5.83 |
| SM | 5.39 | 5.21 | 3.98 | 4.86 | 6.29 | 6.07 | 4.61 | 5.65 |
| Mean | 5.50 | 5.21 | 4.21 | | 6.41 | 6.07 | 4.88 | |
| | S. Em ± | | CD (P = 0.05) | | S. Em ± | | CD (P = 0.05) | |
| M | 0.132 | | 0.386 | | 0.159 | | 0.467 | |
| D | 0.114 | | 0.335 | | 0.138 | | 0.404 | |
| M x D | 0.228 | | NS | | 0.276 | | NS | |

CD at 5% NS - Non-Significant DAT- Days after Transplanting M - Manures
RDF: 125:75:63 kg N: P2O5:K2O ha$^{-1}$ for N equivalent FYM application D - Decomposers
FYM - Farm yard manure VC - Vermicompost PM - Poultry manure SM - Sheep manure
J - Jeevamrutha C - Microbial Consortia N - Decomposer from NCOF

**Table 6:** Quality parameters of Chilli as influenced by application of organic manures, jeevamrutha and decomposers during *kharif 2017*

| Manures | Quality parameter during 2017 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Ascorbic acid (mg 100 g$^{-1}$) | | | | Capsaicin (%) | | | |
| | Decomposers | | | | Decomposers | | | |
| | J | C | N | Mean | J | C | N | Mean |
| FYM | 121.64 | 116.95 | 113.21 | 117.27 | 10.84 | 10.42 | 10.09 | 10.45 |
| VC | 126.05 | 120.51 | 116.10 | 120.89 | 11.23 | 10.74 | 10.34 | 10.77 |
| PM | 125.20 | 119.23 | 115.20 | 119.87 | 11.15 | 10.62 | 10.26 | 10.68 |
| SM | 124.15 | 117.52 | 114.54 | 118.74 | 11.06 | 10.47 | 10.20 | 10.58 |
| Mean | 124.26 | 118.55 | 114.76 | | 11.07 | 10.56 | 10.22 | |
| | S. Em ± | | CD (P = 0.05) | | S. Em ± | | CD (P = 0.05) | |
| M | 3.176 | | 12.256 | | 0.283 | | NS | |
| D | 2.750 | | 8.254 | | 0.245 | | NS | |
| M x D | 5.501 | | NS | | 0.490 | | NS | |
| **Manures** | **Quality parameter during 2017** | | | | | | | |
| | Oleoresin quantity (%) | | | | TSS (ºBrix) | | | |
| | Decomposers | | | | Decomposers | | | |
| | J | C | N | Mean | J | C | N | Mean |
| FYM | 63.53 | 59.46 | 46.12 | 56.37 | 3.52 | 3.29 | 2.53 | 3.11 |
| VC | 68.45 | 64.30 | 57.91 | 63.56 | 3.80 | 3.51 | 3.15 | 3.49 |
| PM | 65.66 | 64.26 | 49.97 | 59.96 | 3.64 | 3.51 | 2.76 | 3.31 |
| SM | 64.20 | 62.04 | 47.43 | 57.89 | 3.56 | 3.44 | 2.62 | 3.21 |
| Mean | 65.46 | 62.52 | 50.36 | | 3.63 | 3.44 | 2.77 | |
| | S. Em ± | | CD (P = 0.05) | | S. Em ± | | CD (P = 0.05) | |
| M | 1.578 | | 4.627 | | 0.087 | | 0.255 | |
| D | 1.366 | | 4.007 | | 0.075 | | 0.221 | |
| M x D | 2.733 | | NS | | 0.151 | | NS | |

CD at 5% NS - Non-Significant DAT- Days after Transplanting M - Manures
RDF: 125:75:63 kg N: P2O5:K2O ha$^{-1}$ for N equivalent FYM application D - Decomposers
FYM - Farm yard manure VC - Vermicompost PM - Poultry manure SM - Sheep manure
J - Jeevamrutha C - Microbial Consortia N - Decomposer from NCOF

**Table 7:** Quality parameters of Chilli as influenced by application of organic manures, Jeevamrutha and decomposers during *kharif* 2018

| Manures | Quality parameter during 2018 | | | | | | | | Shelf life (Days) 2017 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ascorbic acid (mg 100 g$^{-1}$) | | | | Capsaicin (%) | | | | | | | |
| | Decomposers | | | | Decomposers | | | | Decomposers | | | |
| | J | C | N | Mean | J | C | N | Mean | J | C | N | Mean |
| FYM | 126.66 | 120.25 | 115.91 | 120.94 | 11.45 | 10.99 | 10.63 | 11.02 | 23.16 | 22.27 | 21.56 | 22.33 |
| VC | 130.94 | 125.63 | 119.26 | 125.28 | 11.87 | 11.34 | 10.91 | 11.37 | 24.00 | 22.94 | 22.11 | 23.02 |
| PM | 129.96 | 123.59 | 118.58 | 124.04 | 11.79 | 11.21 | 10.82 | 11.28 | 23.84 | 22.70 | 21.93 | 22.82 |
| SM | 128.75 | 121.14 | 116.88 | 122.26 | 11.69 | 11.05 | 10.76 | 11.17 | 23.64 | 22.38 | 21.81 | 22.61 |
| Mean | 129.08 | 122.65 | 117.66 | | 11.70 | 11.15 | 10.78 | | 23.66 | 22.57 | 21.85 | |
| | S. Em ± | | CD (P = 0.05) | | S. Em ± | | CD (P = 0.05) | | S. Em ± | | CD (P = 0.05) | |
| M | 3.435 | | 13.244 | | 0.313 | | NS | | 0.524 | | NS | |
| D | 2.975 | | 8.725 | | 0.271 | | NS | | 1.047 | | NS | |
| M x D | 5.950 | | NS | | 0.542 | | NS | | 0.605 | | NS | |

| Manures | Quality parameter during 2018 | | | | | | | | Shelf life (Days) 2018 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oleoresin quantity (%) | | | | TSS (°Brix) | | | | | | | |
| | Decomposers | | | | Decomposers | | | | Decomposers | | | |
| | J | C | N | Mean | J | C | N | Mean | J | C | N | Mean |
| FYM | 67.56 | 64.94 | 48.66 | 60.38 | 3.32 | 3.09 | 2.35 | 2.92 | 21.28 | 20.20 | 19.47 | 20.32 |
| VC | 72.90 | 67.31 | 60.38 | 66.86 | 3.60 | 3.31 | 2.96 | 3.29 | 22.00 | 21.11 | 20.04 | 21.05 |
| PM | 69.87 | 68.27 | 52.84 | 63.66 | 3.45 | 3.31 | 2.58 | 3.11 | 21.83 | 20.76 | 19.92 | 20.84 |
| SM | 68.29 | 65.94 | 50.09 | 61.44 | 3.36 | 3.24 | 2.44 | 3.02 | 21.63 | 20.35 | 19.64 | 20.54 |
| Mean | 69.66 | 66.61 | 52.99 | | 3.43 | 3.24 | 2.58 | | 21.69 | 20.61 | 19.77 | |
| | S. Em ± | | CD (P = 0.05) | | S. Em ± | | CD (P = 0.05) | | S. Em± | | CD (P= 0.05) | |
| M | 1.734 | | 0.512 | | 0.085 | | 0.249 | | 0.577 | | NS | |
| D | 1.502 | | 4.405 | | 0.074 | | 0.216 | | 0.500 | | NS | |
| M x D | 3.004 | | NS | | 0.147 | | NS | | 1.000 | | NS | |

CD at 5% NS - Non-Significant DAT- Days after Transplanting M - Manures
RDF: 125:75:63 kg N: P2O5:K2O ha$^{-1}$ for N equivalent FYM application D - Decomposers
FYM - Farm yard manure VC - Vermicompost PM - Poultry manure SM - Sheep manure
J - Jeevamrutha C - Microbial Consortia N - Decomposer from NCOF

**Quality parameters**

**Effect of different sources of organic manures and decomposers on quality parameters of Chilli**

The term quality implies the degree of excellence of a product or its suitability for a particular use. Quality of produce encompasses appearance, texture, nutritive values, chemical constituents, mechanical properties, functional properties and defects. Shelf life affects food quality, which in turn influences the consumer's buying decisions. Product quality is very important to growers because it determines marketable yield and can affect price. In present investigation application of vermicompost and Jeevamritha in both experiments improved the quality parameters *viz*., ascorbic acid, TSS content, capsaicin (%), Oleresin quantity and shelf life of Chilli as compared to different sources of organic manure *viz*. FYM, sheep manure, Poutry manure, microbial consortia and decomposer application. The shelf life of Chilli was significantly higher with vermicompost and jeevamrutha. The shelf life ranged between 22.61 to 23.02 days and 20.32 and 21.05 days in refrigerated condition during both the Seasion (Tables 7). These observations with different combinations of vermicompost and Jeevamrutha might be due to thick rind and heavier fruits with low moisture content and lower crude fibre content which might have enhanced the shelf life of fruits.

TSS content ranged from 3.11 to 3.49 °Brix during 2017 and 2.92 to 3.29 °Brix during 2018 was observed with different combinations of vermicompost and jeevamrutha. TSS of Chilli fruits significantly increased with application of organic manures *viz.*, vermicompost, poultry manure, sheep manure and FYM. The minimum total soluble solids (3.11 and 2.92 °Brix) were recorded in FYM whereas, the maximum total soluble solids (3.49 and 3.29 °Brix) were observed in Chilli fruits treated with vermicompost application. The increase in TSS might be due to synthesis of auxin which in turn increased synthesis of metabolites and their rapid translocation from other parts of plants to developing fruits. However, fruits acted as a strong sink for drawing metabolites from the leaves. Similarly, Rajput and Goyal (1991) [35] estimated higher percentage of total soluble solids from the fruits treated with NAA over control. The reason for higher protein might be due to more availability of nutrients particularly nitrogen which is an integral part of protein. The possible reason for increased TSS in organic manure is might be due the increased the activity of the hydrolytic enzyme which converted the complex polysaccharides into simple sugar. Growth regulators also increase translocation of photosynthetic metabolites from other parts of the plant towards to developing fruits. This finding is in conformity with the result of Kumar *et al*., (1998) in guava. Present findings are in line with the findings of Yadav and Vijayakumari (2004). Similarly Kolte *et al.*, (1999) [25], also reported improved sugar content in sugar juice by the application of vermicompost with fertilizer. Regular and uniform water supply to the developing fruits resulted in increased ascorbic acid content and crude protein content in Chilli. Uma Maheshwari and Haripriya (2008) [49] have also reported in pepper that the quality attributes were significantly higher with all the organic manures tested plots compared to inorganic fertilizers. Better quality produce by the application of organic manures is due to better supply of plant nutrients including secondary and micro nutrients and also the growth regulators.

The application decomposers also significantly influenced and improved the quality parameters of Chilli. Among decomposers, the application of Jeevamrutha recorded higher ascorbic acid content (124.26 and 129.08) and oleoresin content (65.46 and 69.66) compared to other sources of

organic manures. The increase in quality attributes with jeevamrurtha might be ascribed to beneficial effects of jeevamrutha. The improvement in the ascorbic acid content of chilli fruits might be due to increased synthesis of metabolites which can stimulate the synthesis of the ascorbic acid precursor (Orzorek and Angell, 1974) [30]. This result is in accordance with the result obtained by Garasiya *et al*. (2013) [20] in guava fruits. According to Hannah *et al.* (2005) who observed better quality parameters of banana fruit *viz*., total sugar, total soluble sugar and reducing sugar. Birendra and Christopher (2007) [9] had also reported higher sensory characters like colour, texture and taste in rice sprayed with jeevamrutha and panchagavya. Thimma (2006) [47] also observed increased oleoresin content from 2.30 to 14.0 per cent and colour value from 2.90 to 6.00 per cent with the application of organics *viz.*, vermicompost, poultry manure and FYM as sources of nutrients to chilli.

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