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# Effect of organic nutrient sources on NPK uptake, soil nutrient status and yield of bell pepper (*Capsicum annuum* L.) under mid hill condition of Himachal Pradesh

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**Abstract**
The field trial was conducted during *Kharif* season of 2016 at Experimental farm of the Department of Vegetable Science, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan to study the effect of organic nutrient sources on NPK uptake, soil nutrient status and yield of bell pepper (*Capsicum annuum* L.) under mid hill condition of Himachal Pradesh. The experiment was laid out in Randomized Complete Block Design (RCBD) Factorial with three replications comprising of ten treatment combinations. The study revealed that vermicompost @ 7 t/ha + Jeevamrut significantly influenced yield and nutrient status of soil as well as nutrient uptake and recorded maximum fruit weight (59.33 g), number of fruits per plant (29.13), fruit yield/plot (24.73 kg) and fruit yield/ha (366.42 q), soil available NPK and uptake of NPK as well. Hence, Vermicompost @ 7 t/ha along with Jeevamrut (3 drenching with Jeevamrut @ 5 per cent at 15 days interval started at the time of transplanting + 2 Foliar Spray of Jeevamrut @ 3 per cent at 15 days interval started 45 DAT) for retention of soil fertility year after year and getting high yield can be recommended for commercial cultivation.

**Keywords:** FYM, Jeevamrut, Vermicompost, Available NPK, NPK uptake and Yield

## 1. Introduction
Bell pepper (*Capsicum annuum* L. var. *grossum* Sendt.) is an important member of Solanaceae family, having chromosome number 2n = 24, also known as sweet pepper, capsicum and Shimla mirch. Capsicum is native to Mexico with secondary centre of diversity in Guatemala (Bukasov, 1930) [5]. Vermicompost promote soil beneficial microbes, dehydrogenase activity (Masciandaro *et al*., 2000) [12], improve soil physical properties and thus providing a suitable medium for root respiration and better growth of the crops. (Biradar *et al*., 2001) [4]. The concept of organic agriculture trusts the effective use of locally available resources, and on the use of well adapted technologies (e.g. management of soil fertility, stopping nutrient cycles, pests and diseases management by their natural enemies). This concept introduces new methods for getting sustainable development and has therefore developed actively over the past decade. Organic agriculture has the potential to improve soil fertility, biodiversity and sustainability of agricultural production; conserve natural resources; improve agronomic and economic performance; make yields more stable, achieve better food quality and food security; provide access to attractive markets through certified products; provide new partnerships within the whole value chain as well as to encourage self-confidence and sustainability of the farmers (Kilcher, 2007) [10].

## 2. Materials and Methods
The present study was carried out at Vegetable Research Farm of the Department of Vegetable Science, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan HP from April to September, 2016. The experiment was laid out in Randomized Complete Block Design (RCBD) Factorial with three replications comprising of ten treatment combination of manure and liquid manure viz. $T_1(M_0L_0)$: No organic manure + No liquid manure (Control), $T_2(M_1L_0)$: FYM @ 20 t/ha + No liquid manure, $T_3(M_2L_0)$ : Vermicompost @ 7 t/ha + No liquid manure,

$T_4$ ($M_3L_0$): FYM @ 10 t/ha + VC 3.5 t/ha + No liquid manure, $T_5$ ($M_4L_0$): FYM @15 t/ha + VC 1.75 t/ha + No liquid manure, $T_6$ ($M_0L_1$): No organic manure + Jeevamrut (Drenching + Foliar Spray), $T_7$ ($M_1L_1$): FYM @ 20 t/ha. + Jeevamrut (Drenching + Foliar Spray), $T_8$ ($M_2L_1$): Vermicompost @ 7 t/ha. + Jeevamrut (Drenching + Foliar Spray), $T_9$ ($M_3L_1$): FYM @10 t/ha + + VC 3.5 t/ha + Jeevamrut (Drenching + Foliar Spray), $T_{10}$ ($M_4L_1$): FYM @ 15 t/ha + VC 1.75 t/ha + Jeevamrut (Drenching + Foliar Spray). The seeds of bell pepper cv. Solan Bharpur were sown in the nursery beds on 5th March, 2016 and the seedlings were transplanted on 26th April, 2016. The plot size was 2.40 m x 2.25 m and a spacing of 60 cm X 45 cm was followed. All the data relating to NPK uptake, available NPK and yield were statistically analyzed as per procedure described by Gomez and Gomez (1984) [6] under the Randomized Complete Block Design (RCBD) Factorial. The results have been interpreted on the basis of 'F' test and the treatments were tested at 5 per cent level of significance. The analysis of the soil was done before planting and it was found that soil was rich in organic matter and having pH, EC and OC values of 7.2, 0.431dSm$^{-1}$ and 1.38 per cent, respectively. The available N, P and K content was recorded to be 395.14, 58.24 and 263.2 kg/ha, respectively.

### 2.1. Soil analysis
Soil samples from 0-15 cm depth were collected from all the plots separately and were air dried, crushed, passed through 2 mm sieve and stored in cloth bags for chemical analysis like soil available NPK.

Available N was determined by alkaline potassium permanganate method (Subbiah and Asija, 1956) [17] and available phosphorus was determined by Olsen's method (Olsen *et al*., 1954) [14] using spectrophotometer. Available potassium was determined by ammonium acetate method using flame photometer (Jackson, 1973) [7].

### 2.2. Plant analysis
The samples collected were immediately weighed and brought to the laboratory in paper bags. All the samples were washed in series, first with tap water, and then with 0.1 N HCl followed by distilled water. The washed samples were allowed to dry in air and subsequently in oven at 60 °C till constant weight. The dried samples were then grinded in a electric grinder and stored in butter paper bags for chemical analysis.

For estimation of N, 0.5 g of plant material was digested in concentrated $H_2SO_4$ in the presence of a digestion mixture. After digestion the N was determined by micro-kjeldahl method. For the estimation of P and K, 0.5 g of the plant sample was digested in 4:1 nitric acid and per chloric acid ($HNO_3$: $HClO_4$) mixture. In order to have complete transfer of the digestion material, three washings of the digestion flask were given with distilled water and volume was made to 100 ml. Potassium in the extract was determined by flame-photometer and P was determined by Vanado-molybdate yellow colour method (Jackson, 1967) [8].

### 2.3. Application of organics
The entire FYM and Vermicompost as per treatment combination per plot were applied evenly by mixing with soil before transplanting of bell pepper seedlings and liquid manure was applied as 3 drenching with Jeevamrut @ 5 per cent at 15 days interval started at the time of transplanting + 2 Foliar Spray of Jeevamrut @ 3 per cent at 15 days interval started after 45 days of transplanting.

## 3. Result and discussion
### 3.1. Yield and yield contributing traits
A perusal of data presented in Table 1 revealed that yield in bell pepper was significantly affected by the application of both the manures and their interactions. The data on different levels of manure revealed that vermicompost treated plots produced significantly more number of fruits per plant (27.00), fruit length (6.54 cm), fruit breadth (5.69 cm), average fruit weight (56.43 g), fruit yield per plot (21.77 kg) and fruit yield q/ha (322.47) and minimum was observed in plots where manure was not applied ($M_0$).

Levels of liquid manure revealed that Jeevamrut ($L_1$) produced maximum number of fruits per plant (25.75), fruit breadth (5.62 cm), average fruit weight (54.43 g), fruit yield per plot (20.20 kg), fruit yield q/ha (299.26) as compared with $L_0$ (No liquid manure). The individual effect of liquid manure as well as its interaction with organic manure was found to be non-significant on fruit length (cm).

The interaction of organic manure and liquid manure levels revealed that maximum number of fruits per plant (29.13), fruit breadth (5.89 cm), average fruit weight (59.33 g), fruit yield per plot (24.73 kg), fruit yield q/ha (366.42), was observed in $M_2L_1$ and minimum of all these characters were recorded in $M_0L_0$(Control).

It may be due to the lucrative role of Vermicompost and Jeevamrut which was helped to a huge amount of beneficial microorganisms and growth promoting substances which might have increased the soil biomass thereby maintaining the availability and uptake of applied as well as native soil nutrients which ultimately resulted in better growth and yield. These results are also supported by findings of (Arancon *et al*., 2003) [2], (Arancon *et al*., 2005) [1], (Natesh *et al*., 2005) [13], (Joshi and Pal Vig, 2010) [9], (Ramesh *et al*., 2015) [15] and (Kumar, 2016) [11].

### 3.2. Available NPK and NPK uptake
The data presented in Table 2 elucidated that there were significant variations in available NPK content and NPK uptake of different levels of liquid manure, organic manure and their interactions. Amongst manure treated plots the maximum available nitrogen (408.46 kg/ha), Phosphorous (70.56 kg/ha), Potassium (274.40 kg/ha) and uptake of nitrogen (153.31 kg/ha), Phosphorous (25.16 kg/ha) and Potassium (122.39 kg/ha) were observed in $M_2$ and minimum of them were recorded in $M_0$ (No manure).

Application of liquid manure ($L_1$) recorded maximum available nitrogen (385.41 kg/ha), Phosphorous (65.41 kg/ha), Potassium (264.21 kg/ha) and uptake of nitrogen (144.08 kg/ha), Phosphorous (23.40 kg/ha) and Potassium (119.47 kg/ha) as compared to $L_0$ (No liquid manure.

The combined effect of both manures divulged that $M_2L_1$ was superior in recording maximum available nitrogen (435.90 kg/ha), Phosphorous (75.04 kg/ha), Potassium (281.12 kg/ha) and uptake of nitrogen (164.71 kg/ha), Phosphorous (26.44 kg/ha) and Potassium (125.39 kg/ha) and they were inferior in $M_0L_0$.

Increase in available N might be due to the direct application of nitrogen through vermicompost and increasing soil microbes, which could transmute organically bound N to inorganic form to the available pool of the soil. Similarly, the increase in available P content might be attributed to the incorporation of vermicompost and Jeevamrut, which attributed to the direct addition of P as well as release of various organic acids on their decomposition chelating with Fe and Al and helps in solubilization of native P. The organic

amendments form a cover on sesquioxides and thus reduce the phosphate fixing capacity of the soil. The beneficial effect of vermicompost and Jeevamrut on available K may be ascribed to the direct potassium addition to the potassium pool of the soil besides the reduction in potassium fixation and its release due to interaction of organic matter with clay particles. It may also be due to the fact that vermicompost and Jeevamrut contains enormous amount of microbial population which multiply and act as a soil tonic. It enhances microbial activity in soil and ultimately ensuring the availability and uptake of nutrients by the crops. It may also be due to more availability of N, P and K which is evident from the result as well. (Sharma *et al*., 2009) [16] obtained similar result from application of vermicompost + RDF. (Azarmi *et al*., 2008) [3] reported increased total N, P and K content from application of vermicompost in tomato. (Yourtchi *et al*., 2013) [18] reported similar result from application of vermicompost + RDF in potato.

**Table 1:** Effect of organic nutrient sources on yield and yield contributing traits

| Particular | Number of fruits per plant | Fruit length (cm) | Fruit breadth (cm) | Fruit weight (g) | Fruit yield kg/plot | Fruit yield q/ha |
|---|---|---|---|---|---|---|
| **Organic manure** | | | | | | |
| $M_0$ | 20.63 | 5.90 | 5.25 | 45.27 | 15.13 | 224.15 |
| $M_1$ | 25.23 | 6.33 | 5.62 | 55.00 | 19.98 | 296.05 |
| $M_2$ | 27.00 | 6.54 | 5.69 | 56.43 | 21.77 | 322.47 |
| $M_3$ | 24.87 | 6.51 | 5.50 | 52.37 | 19.22 | 284.69 |
| $M_4$ | 24.37 | 6.29 | 5.39 | 50.13 | 18.17 | 269.14 |
| $CD_{0.05}$ (M) | 0.64 | 0.24 | 0.03 | 1.30 | 0.41 | 6.04 |
| **Liquid Manure** | | | | | | |
| $L_0$ | 23.09 | 6.25 | 5.36 | 49.25 | 17.51 | 259.34 |
| $L_1$ | 25.75 | 6.38 | 5.62 | 54.43 | 20.20 | 299.26 |
| $CD_{0.05}$ (L) | 0.41 | NS | 0.02 | 0.82 | 0.26 | 3.82 |
| **Interaction(M×L)** | | | | | | |
| $M_0L_0$ | 18.67 | 5.72 | 5.22 | 42.47 | 13.56 | 200.89 |
| $M_0L_1$ | 22.60 | 6.08 | 5.29 | 48.07 | 16.70 | 247.41 |
| $M_1L_0$ | 24.40 | 6.38 | 5.42 | 53.47 | 18.70 | 277.04 |
| $M_1L_1$ | 26.07 | 6.28 | 5.83 | 56.53 | 21.27 | 315.06 |
| $M_2L_0$ | 24.87 | 6.50 | 5.48 | 53.53 | 18.80 | 278.52 |
| $M_2L_1$ | 29.13 | 6.57 | 5.89 | 59.33 | 24.73 | 366.42 |
| $M_3L_0$ | 24.13 | 6.50 | 5.38 | 48.80 | 18.57 | 275.06 |
| $M_3L_1$ | 25.60 | 6.53 | 5.62 | 55.93 | 19.87 | 294.32 |
| $M_4L_0$ | 23.40 | 6.14 | 5.32 | 48.00 | 17.90 | 265.19 |
| $M_4L_1$ | 25.33 | 6.43 | 5.45 | 52.27 | 18.43 | 273.09 |
| **$CD_{0.05}$ (M×L)** | 0.91 | NS | 0.04 | 1.84 | 0.58 | 8.54 |

**Table 2:** Effect of organic nutrient sources on available NPK and NPK uptake

| Particular | available N (kg/ha) | available P (kg/ha) | available K (kg/ha) | N uptake (kg/ha) | P uptake (kg/ha) | K uptake (kg/ha) |
|---|---|---|---|---|---|---|
| **Organic manure** | | | | | | |
| $M_0$ | 292.43 | 42.56 | 214.76 | 107.42 | 18.45 | 108.00 |
| $M_1$ | 386.51 | 61.79 | 264.88 | 141.47 | 23.64 | 119.32 |
| $M_2$ | 408.46 | 70.56 | 274.40 | 153.31 | 25.16 | 122.39 |
| $M_3$ | 375.54 | 60.48 | 259.84 | 133.08 | 22.47 | 118.09 |
| $M_4$ | 369.26 | 57.68 | 252.28 | 130.66 | 21.87 | 115.78 |
| $CD_{0.05}$ (M) | 2.73 | 0.73 | 0.41 | 0.65 | 0.33 | 0.59 |
| **Liquid Manure** | | | | | | |
| $L_0$ | 347.47 | 51.82 | 242.26 | 122.30 | 21.24 | 113.96 |
| $L_1$ | 385.41 | 65.41 | 264.21 | 144.08 | 23.4 | 119.47 |
| $CD_{0.05}$ (L) | 1.72 | 0.46 | 0.26 | 0.41 | 0.21 | 0.37 |
| **Interaction (M×L)** | | | | | | |
| $M_0L_0$ | 283.81 | 39.2 | 209.44 | 103.01 | 17.51 | 106.42 |
| $M_0L_1$ | 301.06 | 45.92 | 220.08 | 111.82 | 19.39 | 109.58 |
| $M_1L_0$ | 370.05 | 53.01 | 254.24 | 129.11 | 23.14 | 117.05 |
| $M_1L_1$ | 402.98 | 70.56 | 275.52 | 153.82 | 24.15 | 121.59 |
| $M_2L_0$ | 381.02 | 66.08 | 267.68 | 141.9 | 23.89 | 119.39 |
| $M_2L_1$ | 435.90 | 75.04 | 281.12 | 164.71 | 26.44 | 125.39 |
| $M_3L_0$ | 354.37 | 52.64 | 245.84 | 120.29 | 21.02 | 115.50 |
| $M_3L_1$ | 396.70 | 68.32 | 273.84 | 145.87 | 23.92 | 120.68 |
| $M_4L_0$ | 348.10 | 48.16 | 234.08 | 117.18 | 20.67 | 111.44 |
| $M_4L_1$ | 390.43 | 67.2 | 270.48 | 144.15 | 23.07 | 120.12 |
| **$CD_{0.05}$ (M×L)** | 3.85 | 1.03 | 0.58 | 0.92 | 0.46 | 0.84 |

## 4. Conclusion

From the present studies, it can be concluded that among different levels of manure, vermicompost performed best for most of the yield, yield contributing traits and soil available NPK and NPK uptake. Among levels of liquid manure application of Jeevamrut performed best for most of the yield and yield contributing traits as well as soil available NPK and NPK uptake. The interaction effect of manure and liquid manure divulged best result from combined application of Vermicompost + Jeevamrut for most of the yield, yield contributing traits, soil available NPK and NPK uptake. Therefore, on the basis of results obtained in present studies,

application Vermicompost in combination with Jeevamrut (3 drenching withJeevamrut @ 5 per cent at 15 days interval started at the time of transplanting + 2 Foliar Spray of Jeevamrut @ 3 per cent at 15 days interval started 45 DAT) for retention of soil fertility and getting high yield can be recommended for commercial cultivation.

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