International Journal of Agricultural Sciences
Volume 8 |Issue 2| June, 2012 | 348-353

RESEARCH PAPER

Effect of organics on the yield parameters of bell pepper under shade house condition

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Abstract : The purpose of the study was to evaluate the effects of organic amendments on yield parameters of capsicum. Field experiments were carried out at Agricultural Research Station, Gangavati, Koppal district, Karnataka for two consecutive seasons of *Rabi* 2005-06 and 2006-07 in the fixed plots. Split plot design with three replications was adopted with two bell pepper varieties *viz*., California Wonder (V_1) and Gangavati Local (V_2) as main plot treatments and nine completely organic nutrient sources along with recommended package of practice nutrients and only recommended inorganic nutrients sources were used as sub plot treatments (O_1 to O_{11}). Results revealed that variety California Wonder performed better with respect to yield (20.21 t/ha) than local variety (16.18 t/ha). Among the nutrient sources O_5 [FYM (50%) + poultry manure (50%) equivalent 100% N RDN-basal] was found significantly superior for yield (19.89 t/ha). The next best treatment for these parameters was O_1 [FYM (50%)+VC (50%) equivalent 100 % RDN (basal)]. Among the various treatment combinations (varieties x organic source of nutrients), the treatment combinations (O_5V_1) were found superior in yield (22.68 t/ha), compared to least yield recorded in inorganic treatments $O_{11}V_1$ (16.87 t/ha) and $O_{11}V_2$ (14.28 t/ha).

Key Words : Capsicum, Yield, Organics, Shade house, Vermicompost, Poultry manure, FYM

View Point Article : Ganiger, Vasant M., Mathad, J.C., Madalageri, M.B., Babalad, H.B. and Bhuvaneswari, G. (2012). Effect of organics on the yield parameters of bell pepper under shade house condition. *Internat. J. agric. Sci.*, **8**(2): 348-353.

Article History : Received : 21.01.2012**; Revised :** 13.03.2012**; Accepted :** 15.04.2012

INTRODUCTION

Bell pepper occupies a pride place among the vegetable in Indian cuisine because its delicacy pleaser flavour with rich colours and nutrients composition. Presently, model capsicum cultivation with a quest to harvest high yield, to cut down indiscriminate use of fertilizers and pesticides which has adversely affected quality of capsicum and physico-chemical properties of soil. Therefore, alternate chemical agriculture system is organic farming which is integrating relation between soil, plant, water, soil micro flora and fauna helps in healthy soil, proper energy flow in soil crop, water environment systems keeps biological life cycle live and helps in sustaining considerable levels in yield (Lampkin, 1990). It is mainly based on principles of restoration of soil organic matter in the form of humus, increasing microbial population, skilful application of the factors contributing soil life and health (Pathak and Ram, 2003). Hence, the present study was undertaken with objectives to know the response of bell pepper to organic sources.

MATERIALS AND METHODS

Experimental details :

The experiment was carried out at Agricultural Research Station, Gangavati during 2006 and 2007 in fixed plot which is situated in northern dry zone of Karnataka (Zone-3) receives rains both from South-West and North-East monsoons and it comes under Tungabhadra command area. The average rainfall received 357.4 mm and 176.4 mm during cropping season (2006

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and 2007, respectively). The soil of experimental site was medium block soil and the composite soil samples were collected from 0-25 cm depth before and after the experimentation and samples were subjected for analysis with respect to their physical and chemical properties.

The experiment included main treatments as two bell pepper varieties *viz*., California Wonder and Gangavati Local. Sub treatments were organic source of nutrients *viz*., O_1; Basal dose application of N equivalent (150 kg/ha) through FYM 50 per cent and vermicompost 50 per cent, O_2; Basal dose application of 75 per cent N equivalent through FYM 50 per cent and vermicompost 25 per cent (37.5 kg N /ha) and top dressing after 45 DAT with 25 per cent (37.5 kg N/ha) N equivalent through vermicompost, O_3; Basal dose application of 150 per cent N equivalent (225 kg N) through FYM 50 per cent (112.5 kg N /ha) and vermicompost 50 per cent (112.5 kg N /ha), O_4; Basal dose application of 150 per cent N equivalent(225 kg N/ha) through FYM 50 per cent (112.5 kg N /ha) and vermicompost 25 per cent (56.25 kg N /ha) and top dressing after 45 DAT with 25 per cent (56.25 kg N/ha) N equivalent through vermicompost, O_5; Basal dose applications of N equivalent (150 kg/ha) through FYM 50 per cent and poultry manure 50 per cent, O_6; Basal dose application of 75 per cent N equivalent through FYM 50 per cent and poultry manure 25 per cent (37.5 kg N /ha) and top dressing after 45 DAT with 25 per cent (37.5 kg N/ha) N equivalent through poultry manure, O_7; Basal dose application of 150 per cent N equivalent (225 kg N) through FYM 50 per cent (112.5 kg N / ha) and poultry manure 50 per cent (112.5 kg N /ha), O_8: Basal dose application of 150 per cent N equivalent(225 kg N/ha) through FYM 50 per cent (112.5 kg N /ha) and poultry manure 25 per cent (56.25 kg N /ha) and top dressing after 45 DAT with 25 per cent (56.25 kg N/ha) N equivalent through poultry manure, O_9; Basal dose application of 150 kg RDN equivalent through FYM in addition to 25 tons/hectare recommended FYM, O_{10}: 150:75: 50 kg/ ha through inorganic fertilizer sources and 25 tons/hectare FYM as per the recommended package (Control 1), O_{11}; 150:75:50 kg/hectare through inorganic fertilizer sources only (Control 2). The experiment was laid out in split plot design with three replications.

The composted FYM and vermicompost were produced on the research farm while poultry manure were purchased from outside. The experimental area was sown with sunhemp (*Crotolaria junicia*) about three months before and the crop was incorporated in to the soil 45 days before the transplanting of bell pepper. The sunhemp incorporation was taken up in all the experimental plots except in the sub plot treatments O_{10} and O_{11}. Later, the plot area was brought to fine tilth by repeated ploughing and harrowing.

The nursery area was ploughed, harrowed and the soil was brought to a fine tilth. The weed free nursery beds of 10 m length, 1 m width with 15 cm height were prepared. While preparation of beds, clear demarcation was made for organic beds and inorganic beds for raising seedlings as per the treatment requirement of the experiments. The beds for raising nursery seedlings for organic nutrient sources treatment were prepared by incorporating well decomposed FYM +sand + red soils. The beds meant for raising seedlings required for inorganic treatments (O_{10} and O_{11}) were incorporated with recommended dose of inorganic fertilizer mixture along with FYM before sowing of the bell pepper seeds. To avoid seed and soil borne diseases the bell pepper seeds were treated with *Trichoderma viridae* before sowing.

Thirty five days age old bell pepper seedlings were transplanting geometry of 60 cm x 45 cm in the Galvanized steel pipe framed structure, 30m length (East-West) and 25 m breadth (North –South) covered with perforated green nylon net which had capacity to allow only 50 per cent of light inside. The roots of the seedlings (except seedling meant for O_{10} and O_{11} treatment) were dipped in the slurry containing biofertilizers *viz*., *Azospirillum*, mycorhizial and phosphorus soluberizing bacterial cultures for ten minutes.

All necessary care and cultural operations were under taken to raise bell pepper crop. However, while diseases and pest were managed by use of only animal or plant origin products (neem oil, NSKE 0.5 per cent, NPV, *Pseudomonas florescence*, *Nomuruea releyi, Trichoderma viridae*, *Hirestela thampane*, *Verticillium lecani)* in organic plots.

Observation of yield parameters:

Five randomly selected plants were tagged in each treatment plot for recording yield parameters *viz*., weight of 10 fruits, number of fruits per plant, yield per plant, yield per plot and fruit quality parameters *viz*., fruit length, fruit breadth, fruit shape, fruit pericarp weight, pericarp thickness at fruit centre, pericarp thickness at blossom end, seed to pericarp ratio, number of seeds per fruit, seed weight per fruit and 100 seed weight and the mean of the observations on these five plants was computed and recorded. The yield per plot was used to compute the yield per hectare and expressed in tonnes.

Statistical analysis and interpretation of the data:

Data generated from the experiments with respect to various parameters were statistically analyzed and interpreted by following Fishers method of analysis of variance as suggested by Panse and Sukhatme (1967). The level of significance used in 'F' and t-test were P=0.05. Critical differences were calculated wherever the 'F' test was found significant.

RESULTS AND DISCUSSION

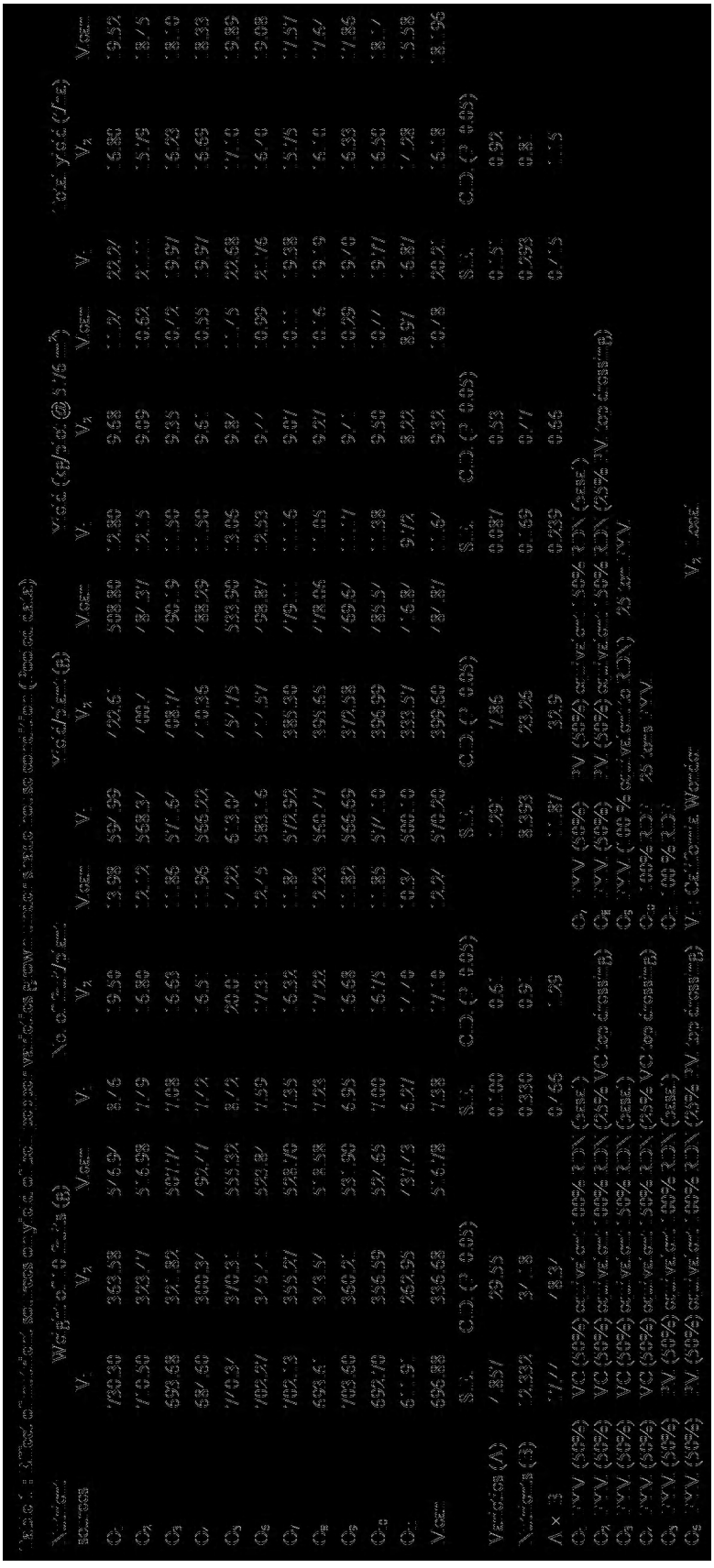
The bell pepper variety California Wonder performed better with respect to number of fruits per plant (7.38), fruits yield (570.20 g) per plant, weight of 10 fruits (696.88 g), number of seeds per fruit (129.87), seed weight per fruit (1.16 g), weight

of 100 seeds (0.75 g), higher pericarp weight per 10 fruits (684.79 g), pericarp thickness at blossom end (1.37 cm), fruit length (6.76 cm) and fruit breadth (6.35 cm) as compared to Local variety (Table 1-4). The yield of California Wonder was significantly higher yield (20.21 t/ha) than Local variety (16.18 t/ha). The treatment O_5 had significant effect on yield attributing parameters like weight of 10 fruit (555.32 g), number of fruits per plant (14.22), fruit yield per plant (533.90 g), fruit breadth (6.01 cm), fruit shape (3.88), pericarp weight (542.66 g/fruit), pericarp thickness at centre (0.74 cm) and total fruit yield (19.89 t/ha). The next best treatment for these parameters was $O_{1.}$

Among the various treatment combinations (varieties x organic source of nutrients), the treatment combinations ($O_5V_{1,}$ $O_1V_{1,}$ O_6V_1) were found superior in yield (22.68 t/ha, 22.24 t/ha and 21.76 t/ha, respectively) compared to least yield recorded in inorganic treatments $O_{11}V_1$ (16.87 t/ha) and $O_{11}V_2$ (14.28 t/ha). The higher yield in the former treatment combination was because of higher growth and yield parameters in these treatments.

These higher values of yield components could be attributed to its genetic capacity to putforth better growth in terms of higher plant height (85.01 cm), number of primary branches (2.05), secondary branches (7.18) per plant and stem girth (1.15 cm). These superior yield parameters as recorded in California Wonder has in turn resulted in higher yield (20.21 t/ha). It seems that the variety has the better genetic capacity to utilize the natural resources like light intensity, temperature, relative humidity and the nutrients as compared to Local variety.

Plant nutrients supplied through organic sources had profound effect on growth and productivity of the crop either by acceleration of respiratory process with increasing cell permeability and hormonal growth action or by combination of all these processes. Through their biological decomposition processes the organic sources supply nutrients to the plants in the available form. They are also rich in micro nutrients besides having plant growth promoting substances *viz.*, hormones, enzymes and humus forming beneficial microbes. Organic sources, on application to the soil, improve the physical properties of soil such as aggregation, aeration, permeability and water holding capacity (Govindarajan and Thangaraju, 2001) which promote growth and development of plants. It has been reported that among the organic sources of nutrients, poultry manure proved to be the best source of organic manure which helped in improving physico-



chemical properties (pH, EC, organic carbon, macro and micro nutrients) of soil because of its higher analytical values (Jeyabaskaran *et al.*, 2001; Naidu *et al.,* 2002). It contained 2.00, 1.97, 4.92 per cent NPK, respectively and 113.2, 71.0, 140.6 and 310.5 mg/kg of total zinc, copper, iron and manganese, respectively (Gopal Reddy, 1997). It has also been experimentally proved that considerable amount of N present in poultry manure consist of uric acid, which is readily available to the plants. The C: N ratio of poultry manure reported to be narrower than FYM, which attenuates the release of nitrogen (Chadwick *et al.*, 2000).

Vermicompost is known to be another good organic source of nutrients which had showed better results because of its higher macro (NPK @ 1.2:0.86 : 0.80%) and micro nutrients, growth hormones, vitamins, antibiotics, enzymes, humic acid, beneficial microbes *etc.*, which have better effect on growth and yield of plants (Anitha *et al.*, 2003). Vermicompost, besides being rich source of macro and micro nutrients, also acts as a chelating agent and regulates the plants by providing nutrients in the available forms. It also contains large quantities of beneficial microbial population and biologically active metabolites, particularly gibberlins, cytokinins, auxins and group B vitamins. These organic sources of nutrients could be applied alone or in combination with inorganic fertilizers so as to get better yield and quality of diverse crops (Bhavalkar, 1991).

The application of 100 per cent recommended dose of nitrogen (RDN) through combination of 50 per cent FYM and 50 per cent poultry manure (O_5) as basal dose recorded significantly higher fruit yield of bell pepper (19.89 t/ha). This could be attributed to the significant increase in yield components *viz.*, number of fruits per plant (14.22), fruits weight/plant (533.90 g), fruit length (6.77 cm), number of seeds per fruit (151.76), seed weight per fruit (1.30 g) and 100 seed weight (0.75 g).

The improvement in yield components could be attributed to the increased vegetative growth parameters of the plant as evidenced by the increase in plant height (94.33 cm), plant spread (53.06 cm), number of primary branches (2.15), secondary branches (6.99) per plant and stem girth (1.22 cm). The increased growth, yield and yield components due to the application of FYM + poultry manure combination may be attributed to their influence on improving physico- chemical properties (pH, EC, organic carbon, macro and micro nutrients) of soil (Jeyabaskaran *et al.*, 2001 and Naidu *et al.,* 2002) favouring the rhizosphere more congenial for nutrient uptake and utilization. Further, considerable amount of nitrogen present in poultry manure consist of uric acid which was readily available to the plant helping them in good growth right from the beginning of the crop.

The second best nutrient combination with respect to yield of bell pepper was application of 100 per cent RDN

Table 2 : Effect of nutrient sources on physical characters of fruits of bell pepper varieties grown under shade house condition (Pooled data)

Nutrient sources	Fruit length (cm)			Fruit breadth (cm)			Fruit shape (Score: 1-5 scale)		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
O_1	6.86	5.44	6.15	6.33	5.19	5.76	3.21	4.16	3.68
O_2	7.58	5.52	6.55	6.42	5.25	5.83	3.18	4.17	3.67
O_3	6.71	5.57	6.14	6.31	5.09	5.70	3.09	4.12	3.60
O_4	6.62	5.16	5.89	6.30	5.12	5.71	3.07	4.34	3.70
O_5	7.05	5.51	6.28	6.77	5.26	6.01	3.27	4.49	3.88
O_6	6.99	5.03	6.01	6.70	5.22	5.96	3.25	4.43	3.84
O_7	6.88	5.74	6.31	6.35	5.43	5.89	3.14	4.24	3.69
O_8	6.77	5.28	6.02	6.34	5.06	5.70	3.09	4.10	3.59
O_9	6.37	5.16	5.76	6.25	5.07	5.66	3.07	4.55	3.81
O_{10}	6.38	5.01	5.69	6.11	4.88	5.49	4.12	4.79	4.45
O_{11}	6.21	4.63	5.42	6.00	4.74	5.37	4.47	4.88	4.67
Mean	6.76	5.27	6.02	6.35	5.11	5.73	3.36	4.38	3.87
	S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)	
Varieties (A)	0.266	1.62		0.090	0.40		0.082	0.50	
Nutrients (B)	0.674	NS		0.315	NS		0.236	0.65	
A × B	0.954	2.64		0.446	1.24		0.334	0.92	
A × B		2.02			0.89			0.69	

O_1- FYM (50%) + VC (50%) equivalent 100% RDN (basal)
O_2- FYM (50%) + VC (50%) equivalent 100% RDN (25% VC top dressing)
O_3- FYM (50%) + VC (50%) equivalent 150% RDN (basal)
O_4- FYM (50%) + VC (50%) equivalent 150% RDN (25% VC top dressing)
O_5- FYM (50%) + PM (50%) equivalent 100% RDN (basal)
O_6- FYM (50%) + PM (50%) equivalent 100% RDN (25% PM top dressing)
O_7- FYM (50%) + PM (50%) equivalent 150% RDN (basal)
O_8- FYM (50%) + PM (50%) equivalent 150% RDN (25% PM top dressing)
O_9- FYM (100 % equivalent to RDN) + 25 ton FYM
O_{10}- 100% RDF + 25 tons FYM
O_{11}-100 % RDF
V_1 : California Wonder V_2- Local

Table 3 : Effect of nutrient sources on fruit pericarp characters of bell pepper varieties grown under shade house condition (Pooled data)

Nutrient sources	Fruit pericarp weight (g/10 fruits)			Pericarp thickness at fruit centre (cm)			Pericarp thickness at blossom end (cm)			Seed : pericarp ratio		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
O_1	714.10	351.70	532.91	0.81	0.61	0.71	1.38	1.17	1.27	0.017	0.033	0.025
O_2	697.43	311.66	504.55	0.76	0.59	0.67	1.44	1.2	1.32	0.018	0.038	0.028
O_3	682.34	310.65	496.50	0.66	0.58	0.62	1.42	1.14	1.28	0.016	0.036	0.026
O_4	673.41	289.36	481.39	0.68	0.53	0.6	1.36	1.23	1.29	0.016	0.039	0.028
O_5	726.89	358.43	542.66	0.84	0.64	0.74	1.54	1.2	1.37	0.018	0.036	0.027
O_6	689.34	332.24	510.79	0.81	0.62	0.71	1.49	1.2	1.34	0.018	0.037	0.028
O_7	690.41	343.60	517.01	0.74	0.59	0.66	1.42	1.17	1.29	0.017	0.033	0.025
O_8	683.15	332.52	507.83	0.69	0.57	0.63	1.44	1.11	1.27	0.016	0.034	0.025
O_9	691.27	348.49	519.88	0.66	0.52	0.59	1.37	1.11	1.24	0.017	0.034	0.026
O_{10}	681.90	347.61	514.76	0.51	0.45	0.48	1.22	1.05	1.13	0.014	0.026	0.020
O_{11}	602.49	254.58	428.54	0.47	0.41	0.44	1.04	0.96	1.00	0.015	0.032	0.023
Mean	684.79	325.53	505.17	0.69	0.55	0.62	1.37	1.14	1.25	0.017	0.034	0.026
	S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)	
Varieties (A)	0.189	1.15		0.0139	0.61		0.0239	0.15		0.0001	0.0006	
Nutrients (B)	0.462	1.28		0.05	0.14		0.0594	0.16		0.0003	0.0008	
A × B	0.654	1.81		0.0706	0.19		0.084	0.23		0.0004	0.0011	
A × B		1.92			0.44			0.18			0.0012	

O_1- FYM (50%) + VC (50%) equivalent 100% RDN (basal)
O_2- FYM (50%) + VC (50%) equivalent 100% RDN (25% VC top dressing)
O_3- FYM (50%) + VC (50%) equivalent 150% RDN (basal)
O_4- FYM (50%) + VC (50%) equivalent 150% RDN (25% VC top dressing)
O_5- FYM (50%) + PM (50%) equivalent 100% RDN (basal)
O_6- FYM (50%) + PM (50%) equivalent 100% RDN (25% PM top dressing)
O_7- FYM (50%) + PM (50%) equivalent 150% RDN (basal)
O_8- FYM (50%) + PM (50%) equivalent 150% RDN (25% PM top dressing)
O_9- FYM (100 % equivalent to RDN) + 25 ton FYM
O_{10}- 100% RDF + 25 tons FYM
O_{11}-100 % RDF
V_1 : California Wonder V_2- Local

Table 4 : Effect of nutrient sources on seed content of bell pepper varieties grown under shade house condition

Nutrient sources	No. of seeds /fruit			Seed weight/fruit (g)			100 seed weight (g)		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
O_1	141.67	125.37	133.52	1.24	1.18	1.21	0.79	0.66	0.72
O_2	139.39	124.00	131.69	1.26	1.18	1.22	0.81	0.64	0.72
O_3	126.36	113.97	120.16	1.14	1.12	1.13	0.78	0.61	0.69
O_4	125.29	111.35	118.32	1.11	1.13	1.12	0.75	0.61	0.68
O_5	159.98	143.54	151.76	1.33	1.28	1.30	0.84	0.66	0.75
O_6	159.49	140.25	149.87	1.30	1.24	1.27	0.82	0.65	0.73
O_7	134.17	124.77	129.47	1.17	1.13	1.15	0.76	0.59	0.67
O_8	122.32	125.73	124.02	1.15	1.12	1.13	0.76	0.61	0.68
O_9	119.31	117.00	118.15	1.25	1.18	1.21	0.70	0.59	0.64
O_{10}	104.18	92.53	98.35	0.98	0.89	0.93	0.65	0.48	0.56
O_{11}	96.42	87.57	91.99	0.91	0.80	0.85	0.63	0.41	0.52
Mean	129.87	118.73	124.30	1.16	1.11	1.14	0.75	0.59	0.67
	S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)	
Varieties (A)	0.256	3.59		0.008	NS		0.003	0.02	
Nutrients (B)	1.088	3.96		0.009	0.05		0.006	0.01	
A × B	1.538	5.60		0.013	0.06		0.009	0.03	
A × B		4.15			0.07			0.02	

O_1- FYM (50%) + VC (50%) equivalent 100% RDN (basal)
O_2- FYM (50%) + VC (50%) equivalent 100% RDN (25% VC top dressing)
O_3- FYM (50%) + VC (50%) equivalent 150% RDN (basal)
O_4- FYM (50%) + VC (50%) equivalent 150% RDN (25% VC top dressing)
O_5- FYM (50%) + PM (50%) equivalent 100% RDN (basal)
O_6- FYM (50%) + PM (50%) equivalent 100% RDN (25% PM top dressing)
O_7- FYM (50%) + PM (50%) equivalent 150% RDN (basal)
O_8- FYM (50%) + PM (50%) equivalent 150% RDN (25% PM top dressing)
O_9- FYM (100 % equivalent to RDN) + 25 ton FYM
O_{10}- 100% RDF + 25 tons FYM
O_{11}-100 % RDF
V_1 : California Wonder V_2- Local

equivalent nutrient through FYM + vermicompost (19.52 t/ha). These nutrient sources helped in the significant improvement in yield attributing traits like number of fruits per plant (13.98), fruits weight/plant (508.80 g), fruit length (6.15 cm), fruit breadth (5.76 cm), pericarp thickness at blossom end (1.27 cm), number of seeds per fruit (133.52), seed weight per fruit (1.22 g) and 100 seed weight (0.72 g) through the improvement in growth parameters of the plant as evident in the increase of plant height (93.15 cm), secondary branches (6.79) per plant and stem girth (1.17 cm). The vermicompost component in this treatment combination is known to enhance microbial activity which might have improved the availability of macro and micro nutrients. It has also the capacity to act as chelating agent and regulates the availability of metabolic micro nutrients to the plants and thus helped in increasing the plant growth and yield attributing traits by providing nutrients in the available form. Besides, vermicompost also contains significant quantities of nutrients, a large amount of beneficial microbial populations and biologically active metabolites particularly gibberlins, cytokinins, auxins and group B vitamins (Bhavalkar, 1991) all of which have beneficial effect on photosynthesis and translocation and transformation in to the development of fruits which are the economic part of the plant.

Among the interactions, plants receiving 100 per cent RDN through 50 per cent FYM and 50 per cent poultry manure (O_5) as a basal application recorded an appreciably higher yield (19.85 t/ha) of bell pepper. This could be attributed to the significant increase in yield components *viz.*, number of fruits per plant (14.22), fruit length (6.28 cm), fruit breadth (6.01 cm), number of seeds per fruit (151.76), seed weight per fruit (0.84 g) and pericarp weight (542.66 g/10 fruits).

Conclusion:

The effect of organic sources has profound effect on yield parameters of bell pepper varieties grown in shade house condition. The treatment combination *i.e.*, Basal dose applications of N equivalent (150 kg/ha) through FYM 50 per cent and poultry manure 50 per cent in the variety California Wonder had significant response to yield parameters like fruit yield and yield attributing factors like weight of 10 fruits, number of fruits per fruit, fruit yield per plant, seed weight per fruit and total yield.

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