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Effect of organics and inorganics on yield parameters in bell pepper under open condition

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ABSTRACT

Investigations were carried out to study the effect of organics on yield and fruit quality parameters in bell pepper grown under open condition. Split plot design, with three replications, was adopted taking two bell pepper varieties, viz., California Wonder and Gangavati Local (as main-plot treatments) and nutrient source (as sub-plot treatments). Variety California Wonder performed better with respect to yield parameters compared to the Local variety. Application of 100% recommended dose of nitrogen (RDN) through a combination of 50% FYM and 50% poultry manure (O_5) as basal dose recorded significantly higher fruit yield (16.33 t/ha) and yield components over other treatments. Among interactions, O_5 (FYM (50%) + poultry manure (50%) recorded significantly higher fruit yield (18.47 t/ha), followed by 18.31 t/ha with organic application in O_1 (FYM (50%) + Vermicompost (50%) in California Wonder variety.

Key words: Organics, bell pepper, open condition, vermicompost, poultry manure, FYM

INTRODUCTION

Bell pepper has attained the status of a high-value crop in India in recent years and occupies a pride of place among vegetables in Indian cuisine because it is a delicacy with a pleasant flavour coupled with rich colours (green, red, yellow, *etc.*) and high content of ascorbic acid and other vitamins, and minerals. Modern agriculture, depends largely on chemical fertilizers, pesticides, herbicides, etc., resulting in increased production. This has adversely affected soil productivity and environment quality. Heavy use of chemical fertilizers, pesticides and fungicides causes health hazards and environmental pollution apart from imparting resistance to pest against chemical pesticides and fungicides. Modern or industrial farming has also led to concerns on ecological, economical, soil and human health, philosophical front, etc. Therefore, these days, organic farming is gaining importance steadily.

Bell pepper is a high-value crop, and in a quest to harvest high yields, fertilizers and pesticides find indiscriminate use in its cultivation. But, information on organic cultivation of bell pepper is rather scanty. Hence, the present study was undertaken with an objective to study the response of bell pepper to organic sources of nutrients and its effect on yield and fruit quality.

MATERIAL AND METHODS

Experimental details

The experiment was carried out at Agricultural Research Station, Gangavati, during 2006 and 2007 in a fixed plot situated in the Northern dry zone of Karnataka (Zone-3) that receives rains from both South-West and North-East monsoon and falls under the Tungabhadra command area. Average rainfall received here was 357.4mm and 176.4mm during the cropping seasons (2006 and 2007, respectively).

The experiment included main treatments and two bell pepper varieties, viz., California Wonder and Gangavati Local. Sub-treatments of organic sources of nutrients were as follows:

O_1: Basal dose of N equivalent (150 kg/ha) through FYM 50% and Vermicompost 50%

O_2: Basal dose of 75% N equivalent through FYM 50% and Vermicompost 25 % (37.5 kg N /ha) and top dressing after 45 DAT with 25% (37.5 kg N/ha) N equivalent through Vermicompost

O_3: Basal dose of 150% N equivalent (225 kg N) through FYM 50% (112.5kg N /ha) and Vermicompost 50% (112.5 kg N /ha)

O_4: Basal dose of 150% N equivalent (225kg N/ha) through

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FYM 50% (112.5kg N /ha) and Vermicompost 25% (56.25kg N /ha) and top dressing after 45 DAT with 25% (56.25kg N/ha) N equivalent through Vermicompost

O_5: Basal dose of N equivalent (150kg/ha) through FYM 50% and poultry manure 50%

O_6: Basal dose of 75% N equivalent through FYM 50% and poultry manure 25% (37.5kg N /ha) and top dressing after 45 DAT with 25% (37.5kg N/ha) N equivalent through poultry manure

O_7: Basal dose of 150% N equivalent (225kg N) through FYM 50% (112.5kg N /ha) and poultry manure 50% (112.5kg N /ha)

O_8: Basal dose of 150% N equivalent (225kg N/ha) through FYM 50% (112.5kg N /ha) and poultry manure 25% (56.25kg N /ha) and top dressing after 45 DAT with 25% (56.25kg N/ha) N equivalent through poultry manure

O_9: Basal dose of 150kg RDN equivalent through FYM, in addition to 25 tons/hectare of recommended FYM

O_{10}: NPK 150:75:50kg/ ha inorganic fertilizer source and 25 tons/hectare FYM as per recommended package (Control 1)

O_{11}: NPK 150:75:50kg/hectare inorganic fertilizer source only (Control 2).

The experiment was laid out in split plot design, with three replications. Nutrient composition of manures used in the experiment is given in Table 1.

The experimental area was grown with sun hemp (*Crotalaria juncea*) for three months and the sun hemp crop was incorporated into the soil 45 days before transplanting bell pepper. This was done in all the experimental plots except sub-plot treatments O_{10} and O_{11}. Beds for raising nursery seedlings for organic nutrient sources treatment were prepared by incorporating well-decomposed FYM + sand + red soil. Beds for raising seedlings under inorganic treatments (O_{10} and O_{11}) were incorporated with the recommended dose of inorganic fertilizer mixture, along with FYM, before sowing bell pepper seeds. To avoid seed or soil borne diseases, bell pepper seeds were treated with *Trichoderma viridae* prior to sowing.

Table 1. Nutrient composition and other properties of manures used

Particulars	FYM	Vermicompost	Poultry manure
pH	7.13	7.08	7.19
EC (dS/m)	0.29	1.24	1.39
Total nutrient content (macro- and micro-) (%)			
N	0.50	1.21	1.50
P	0.24	0.82	1.56
K	0.53	1.03	2.38
Ca	0.22	0.58	1.40
Mg	0.18	0.22	0.36
S	0.23	0.39	0.53
Total micronutrient content (mg/kg)			
Zn	135.00	269.40	228.00
Mn	181.20	251.80	261.40
Cu	22.10	27.60	48.00
Fe	251.30	382.00	1110.00

Thirty-five day old bell pepper seedlings were transplanted at a spacing of 60cm x 45cm. Roots of the seedlings, except in O_{10} and O_{11} treatments, were dipped in a slurry containing biofertilizers, viz., *Azospirillum*, mycorrhizial and phosphorus solubilizing bacteria cultures, for 10 minutes.

All necessary cultural operations were undertaken to raise the bell pepper crop. Diseases and pests were managed using products of animal or plant origin (*neem* oil, NSKE 0.5%, NPV, *Pseudomonas fluorescence, Nomuruea releyi, Trichoderma viridae, Hirestela thampane* and *Verticillium lecani)* in the organic plots.

Fruit and yield characteristics

Five randomly selected plants were tagged in each treatment plot for recording fruit and yield parameters, viz., weight of 10 fruits, number of fruits per plant, yield per plant, yield per plot, fruit length, fruit breadth, fruit shape, fruit pericarp weight, pericarp thickness at the centre of the fruit, pericarp thickness at blossom end, seed to pericarp ratio, number of seeds per fruit, seed weight per fruit and 100 seed weight. Yield per plot was used for computing yield per hectare and was expressed as t/ha.

Statistical analysis

Data were statistically analyzed following Fishers method of Analysis of Variance, as suggested by Panse and Sukhatme (1967). Level of significance was computed at P=0.05.

RESULTS AND DISCUSSION

Data presented in Table 2 show that the cv. California Wonder produced heavier fruits (621.5 g/10 fruits) and highest fruit yield (423.30 g/plant) over the Local cultivar (254.56 g/10 fruits and 332.20g, respectively). Cultivar California Wonder performed better with respect to fruit characters, *viz.*, fruit length (6.33cm), fruit breadth (5.41cm), pericarp weight (607.65 g/10 fruits), pericarp thickness at

Table 2. Effect of nutrient source on yield in bell pepper varieties grown under open-field condition (pooled data of 2006 and 2007)

Nutrient source	Weight of 10 fruits (g)			No. of fruits/plant			Total yield (t/ha)		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
O_{-1}	644.42	268.04	456.23	6.93	16.31	11.62	18.31	13.96	16.14
O_2	639.32	260.17	449.74	6.65	17.77	10.73	16.95	13.33	15.14
O_{-3}	693.18	246.90	470.03	6.35	14.51	10.43	16.98	13.27	15.12
O_{-4}	678.80	256.57	467.68	6.37	13.51	9.94	16.08	12.98	14.53
O_{-5}	730.46	278.63	504.55	6.91	16.33	11.62	18.47	14.18	16.33
O_{-6}	681.18	265.58	473.38	6.36	16.43	11.37	17.71	13.29	15.50
O_{-7}	593.63	251.21	422.42	6.28	14.26	10.27	16.90	12.80	14.85
O_{-8}	538.19	254.47	396.33	6.16	14.11	10.14	16.78	12.43	14.61
O_{-9}	569.22	248.25	408.74	6.03	14.30	10.16	16.39	12.17	14.28
O_{-10}	580.50	250.21	415.35	6.12	13.81	9.96	16.88	12.51	14.69
O_{-11}	482.65	220.10	351.38	5.60	11.28	8.44	14.65	11.12	12.88
Mean	621.05	254.56	437.80	6.341	14.78	10.43	16.92	12.91	14.92
	CD at *(P=0.05)*	SEm±		CD at *(P=0.05)*	SEm±		CD at *(P=0.05)*	SEm±	
Variety (A)	55.55	9.129		0.40	0.065		2.44	0.648	
Nutrient source (B)	123.53	29.510		1.26	0.453		0.74	0.311	
A × B	115.68	41.734		1.77	0.641		1.04	0.440	

V1 = California Wonder , V2 = Gangavati Local

blossom end (1.36cm), number of seeds per fruit (128.24), seed weight per fruit (1.21g) and weight of 100 seeds (0.72g) as compared to the Local variety (Tables 3-5). These higher values for yield components in cv. California Wonder can be attributed to the variety's capacity to utilize natural resources like light intensity, temperature, relative humidity and nutrients, compared to Gangavati Local cultivar.

Present research findings show that yield in bell pepper differed significantly with respect to the source of nutrients. The application of 100% recommended dose of nitrogen (RDN) through combination of 50% FYM and 50% poultry manure (O_5) as basal dose recorded significantly higher fruit yield of bell pepper (16.33 t/ha). This could be attributed to the significant increase in yield components, *viz.*, number of fruits (11.62) and fruit weight/plant (411.47g).

Improvement in yield components may be attributed to increased vegetative growth of the plant through increase in plant height (94.33 cm), plant spread (45.83 cm), number of primary branches per plant (2.61), secondary branches (7.58) and stem girth (1.07cm) (Vasant, 2010). Increase in growth, yield and yield components due to application of FYM + poultry manure combination may -nutrients) of soil (Jeyabaskaran *et al*, 2001; Naidu *et al*, 2002). The rhizosphere is, thus, more congenial to the plant for nutrient uptake and utilization. Further, considerable amount of nitrogen is present in poultry manure in the form of uric acid. This is readily available to the plant, helping it put forth good growth right from the onset of the crop.

Table 3. Effect of nutrient source on physical characters in bell pepper varieties grown under Open-field condition (pooled data of 2006 and 2007)

Nutrient source	Fruit length (cm)			Fruit breadth (cm)		
	V_1	V_2	Mean	V_1	V_2	Mean
O_{-1}	6.27	5.19	5.73	5.36	4.78	5.07
O_2	6.10	5.17	5.63	4.45	4.78	4.61
O_{-3}	6.11	5.67	5.89	5.43	4.83	5.13
O_{-4}	6.38	4.95	5.66	5.84	4.88	5.36
O_{-5}	6.81	5.67	6.24	5.68	4.63	5.15
O_{-6}	7.55	5.30	6.42	5.67	4.98	5.32
O_{-7}	6.68	5.78	6.23	5.43	5.14	5.28
O_{-8}	5.75	5.11	5.43	5.34	4.93	5.13
O_{-9}	5.97	5.34	5.65	5.71	4.77	5.24
O_{-10}	6.20	4.96	5.58	5.44	4.30	4.87
O_{-11}	5.88	4.36	5.12	5.18	3.97	4.57
Mean	6.33	5.22	5.78	5.41	4.72	5.06
	CD *(P=0.05)*	SEm±		CD *(P=0.05)*	SEm±	
Variety (A)	0.40	0.0658		0.09	0.0157	
Nutrient source (B)	NS	0.5120		0.10	0.2159	
A × B	2.01	0.7240		0.14	0.3054	
A × B	1.37			0.57		

V_1 = California Wonder, V_2 = Gangavati Local

The second best nutrient combination with respect to yield in bell pepper was application of 100% RDN equivalent nutrient through FYM + Vermicompost (16.14 t/ha). These nutrient sources resulted in significant improvement in yield attributing traits like: number of fruits per plant (11.62), fruit weight/plant (400.89g), fruit length (5.73cm), fruit breadth (5.07cm), pericarp thickness at blossom end (1.26cm), number of seeds per fruit (132.25), seed weight per fruit (1.19g) and 100 seed weight (0.70g) This was made possible through improvement in growth parameters of the plant as

Table 4. Effect of nutrient source on fruit pericarp characters in bell pepper varieties grown under open-field condition (pooled data of 2006 and 2007)

Nutrient source	Fruit pericarp weight (g/10 fruits)			Pericarp thickness at centre of the fruit (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}	633.66	254.80	444.23	0.79	0.62	0.70	1.35	1.17	1.26	0.019	0.044	0.032
O_2	627.04	248.97	438.00	0.75	0.61	0.68	1.40	1.14	1.27	0.020	0.047	0.033
O_{-3}	680.84	239.77	460.31	0.66	0.39	0.52	1.34	1.15	1.24	0.018	0.046	0.032
O_{-4}	666.92	245.19	456.06	0.65	0.54	0.59	1.36	1.06	1.21	0.017	0.044	0.031
O_{-5}	708.14	264.95	486.54	0.79	0.48	0.63	1.51	1.16	1.33	0.017	0.047	0.032
O_{-6}	669.27	256.53	462.90	0.72	0.62	0.67	1.39	1.13	1.26	0.017	0.047	0.032
O_{-7}	581.42	241.08	411.25	0.72	0.59	0.65	1.46	1.12	1.29	0.020	0.048	0.034
O_{-8}	527.34	243.16	392.75	0.64	0.61	0.62	1.40	1.08	1.24	0.021	0.047	0.034
O_{-9}	553.38	236.55	394.97	0.61	0.57	0.59	1.40	1.07	1.23	0.022	0.050	0.036
O_{-10}	564.77	240.27	402.52	0.51	0.48	0.49	1.23	1.04	1.13	0.029	0.040	0.034
O_{-11}	471.35	211.59	341.47	0.44	0.43	0.43	1.17	0.98	1.07	0.019	0.035	0.027
Mean	607.65	243.90	426.45	0.66	0.54	0.60	1.36	1.10	1.23	0.020	0.045	0.032
	CD at *(P=0.05)*	SEm±		CD at *(P=0.05)*	SEm±		CD at *(P=0.05)*	SEm±		CD at *(P=0.05)*	SEm±	
Variety (A)	6.11	1.000		0.08	0.013		0.06	0.0094		0.016	0.001	
Nutrient source (B)	11.13	4.016		0.11	0.041		0.12	0.0429		0.005	0.002	
A × B	15.74	5.680		0.16	0.058		0.17	0.0607		0.007	0.003	

V_1 = California Wonder, V_2 = Gangavati Local

Table 5. Effect of nutrient source on seed traits in bell pepper varieties grown under open-field condition (pooled data of 2006 and 2007)

Nutrient source	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}	138.40	126.09	132.25	1.25	1.13	1.19	0.75	0.65	0.7
O_2	137.69	128.25	132.97	1.25	1.19	1.22	0.75	0.64	0.69
O_{-3}	126.69	118.92	122.81	1.21	1.11	1.16	0.75	0.63	0.69
O_{-4}	123.13	114.99	119.06	1.16	1.12	1.14	0.82	0.60	0.71
O_{-5}	152.28	132.69	142.49	1.21	1.24	1.22	0.74	0.64	0.69
O_{-6}	147.03	133.07	140.05	1.19	1.22	1.20	0.75	0.60	0.67
O_{-7}	124.59	125.10	124.85	1.18	1.17	1.17	0.73	0.56	0.64
O_{-8}	138.77	123.19	130.98	1.11	1.13	1.12	0.73	0.69	0.71
O_{-9}	124.57	118.27	121.42	1.23	1.19	1.21	0.67	0.60	0.63
O_{-10}	103.69	105.54	104.62	1.65	0.95	1.30	0.69	0.56	0.62
O_{-11}	93.83	85.43	89.63	0.89	0.75	0.82	0.58	0.44	0.51
Mean	128.24	119.23	123.74	1.21	1.1091	1.16	0.72	0.60	0.66
	CD at *(P=0.05)*	SEm±		CD at *(P=0.05)*	SEm±		CD at *(P=0.05)*	SEm±	
Variety ((A)	1.53	NS		0.026	NS		0.0230	NS	
Nutrient source (B)	2.77	7.67		0.063	0.175		0.0250	0.072	
A × B	3.91	10.85		0.089	0.248		0.0354	0.101	
A × B		9.23			0.192			0.110	

V_1 = California Wonder , V_2 = Gangavati Local

evident by increased plant height (71.05cm), secondary branches per plant (7.51) and stem girth (1.14cm). Vermicompost used in this treatment combination is known to enhance microbial activity, which may have improved availability of macro- and micro-nutrients to the plants. It also acts as a chelating agent and regulates availability of metabolic micro-nutrients to plants and, thus, helps increase plant growth and yield-attributing traits by providing nutrients in their available form. Besides, vermicompost also contains significant quantities of nutrients, a large amount of beneficial microbial populations and biologically active metabolites particularly, gibberellins, cytokinins, auxins and group B vitamins (Bhavalkar, 1991) all of which have a beneficial effect on photosynthesis and translocation. Results of the present findings are in agreement with findings of several earlier workers, viz., Basavaraja *et al* (2003), Salas and Ramirez (2001), Jeevansab (2000) and Kalembasa and Deska (1998) in capsicum.

Organic nutrient sources, on application to soil improve its physical properties like aggregation, aeration, permeability and water holding capacity (Govindarajan and Thangaraju, 2001) thereby promoting growth and development of plants. It has been reported that among organic sources of nutrients, poultry manure is the best source for improving the physico-chemical properties of soil (Jeyabaskaran *et al*, 2001; Naidu *et al*, 2002). Poultry manure contained 2.00, 1.97 and 4.92% NPK, respectively, and 113.2, 71.0, 140.6 and 310.5 mg/kg of total amount of zinc, copper, iron and manganese, respectively (Gopal Reddy, 1997). It has also been experimentally proved that considerable amount of N is present as uric acid which is readily available to plants. C: N ratio of poultry manure is reported to be narrower than in FYM which attenuates release of nitrogen (Chadwick *et al*, 2000).

Vermicompost is known to be another good organic source of nutrients showing good results. This may be due to higher macro- and micro-nutrients, growth hormones, vitamins, antibiotics, enzymes, humic acid, beneficial microbes, etc. in it. Vermicompost also acts as a chelating agent and regulates growth of plants by providing nutrients in their available form. These organic sources of nutrients can be applied either alone or in combination with inorganic fertilizers to obtain better yields and quality in a diverse array of crops (Bhavalkar, 1991).

Organic nutrient sources have a profound effect on yield parameters in bell pepper varieties grown under open condition. The treatment combination of basal application of N (150kg/ha) equivalent to FYM 50% and poultry manure 50% in the variety California Wonder significantly improved fruit yield and yield attributing factors like weight of 10 fruits, number of fruits per plant and seed weight per fruit.

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