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Integration of panchagavya, neemcake and vermicompost improves the quality of chilli production

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Abstract

The present investigation was conducted in a factorial randomised block design to evaluate the performance of two chilli varieties (V_1: CH-27 and V_2: Eagle-53) after application of various organic (neem cake, panchagavya and vermicompost) and inorganic nutrient sources. Among the treatments, T_{10} (neem cake @ 250 kg/ha with recommended fertiliser doses of 100:50:50 kg of nitrogen, phosphorus, and potassium per ha) produced the highest average plant height (86.28 cm) and average fruit weight (4.36 g). The application of T_8 (vermicompost @ 1 ton/ha with neem cake @ 250 kg/ha) resulted in the highest fruit yield (465.73 g/plant and 172.46 q/ha), while the application of T_6 (panchagavya at 3 percent with neem cake at 250 kg/ha) resulted in the highest capsaicin content (0.46 g/g). However, the interaction between the nutrient treatments and varieties was significant, with T_8V_1 having the highest yield (188.75 q/ha) and benefit:cost (B:C) ratio (4.3). The application of vermicompost @ 1 ton/ha in combination with neem cake @ 250 kg/ha was found as the best treatment for high economic yield with no significant deviation in fruit quality. The CH-27 cultivar was superior because of its high yield, superior fruit quality, and high income.

Key words: B:C ratio, chilli, neem cake, panchagavya, vermicompost

Introduction

Chilli (*Capsicum annuum* L.), a member of Solanaceae family, is native to tropical South America. Chilli can be utilized as both green vegetable and spice. It is rich in proteins, lipids, starches, minerals (Fe, Ca, P) and vitamins D_3, A, E, K, C, B_{12} and B_2 (El-Ghorab *et al.,* 2013). The pungency in chilli is because of alkaloid capsaicin and is of high therapeutic value specially for instant pain relief. It is well established that for achieving optimum growth and higher productivity, fertilization plays a very important role by providing the plants with essential nutrients. Similarly, in chilli cultivation, the use of inorganic fertilizers has reportedly been increased to obtain a higher yield per hectare (Islam *et al.,* 2018). With the use of nitrogenous fertilizers in chilli an enormous increase in fruit weight, yield and fruit counts has been reported. But along with providing essential nutrients, continuous application of inorganic fertilizers also increases the cost of production, makes the soil toxic with the residual activity and leads to many unmeasured environmental damages which have been reviewed and reported by many workers and environment enthusiasts. To take care of the issues related with the utilization of inorganic fertilizers, as of late, the move is towards natural formulation, a technique that focuses on the ecology health (Khandaker, 2017).

There are numerous ways to practice organic farming with several improved practices like use of vermicompost, liquid organic manures, traditional organic formulations like panchgavya, bio fertilizers like *Azotobacter, Azospirillum, Rhizobium*, VAM and PSB. Vermicompost is high in organic matter, containing plant and/or animal waste products which are developed through action of earthworms to bring some biochemical and physical manipulation including disintegration, humification and acid hydrolysis. Panchagavya is the natural mixture of five items acquired from cow *viz.* curd, milk, excrement, urine and ghee, every one of these items are independently called as "Gavya" and all together named as panchagavya (Natarajan, 2002). It is a blended culture of commonly available, helpful organisms' which include lactic acid bacteria (*Lactobacillus*), yeast (Saccharomyces), actinomyces (Streptomyces) and certain microbes which have been reported to advance the growth and yield. Panchagavya can be a growth enhancing natural product for farmers and is exceptionally low at cost (Shailaja *et al.,* 2014). Another organic formulation, neem cake is acquired from the neem seed which have been squashed to separate the oil and is rich in N-P-K content. Neem cake has been known to enhance the soil properties and ensure the safety of plant because of its characteristic pesticidal nature (Jinsa *et al.,* 2012). Considering the capability of natural or organic formulations in crop production and interpret ecological issues the investigation was carried with the objectives to evaluate the performance and economics of chilli cultivation after application of natural or organic formulations as nutrient sources.

Materials and methods

The research work was carried out during 2019-2020, at main experiment farm of agriculture, Lovely Professional University, Phagwara, Punjab (India). The temperature reached above 40 °C during summer and during winter the temperature went down below 10 °C. June was the hottest month and December being the coldest month. The highest rainfall was recorded during the month

of July and the driest month was October. The soil predominantly belongs to central alluvial plain or sandy loam.

The investigation was carried out with factorial randomized block design consisting two factors *viz.,* two varieties of chilli (V_1- CH-27, V_2- Eagle-53) and eleven different combinations of organic and inorganic nutrient sources (T_1- panchagavya @ 3%, T_2-vermicompost @ 1 ton per ha, T_3- neem cake @ 250 kg per ha, T_4- RDF (Recommended Dose of Fertilizers) @ 100:50:50 kg/ha, T_5- panchagavya @ 3% + vermicompost @ 1 ton per ha, T_6- panchagavya @ 3% + neem cake @ 250 kg per ha, T_7- panchagavya @ 3% + RDF 100:50:50 kg per ha, T_8- vermicompost @ 1 ton per ha + neem cake @ 250 kg per ha, T_9-vermicompost @ 1 ton per ha + RDF @ 100:50:50 kg per ha, T_{10}- neem cake @ 250 kg per ha + RDF @ 100:50:50 kg per ha, T_{11}- control). The procedure of punchagavya preparation is given in Fig. 1.

The land was ploughed with the help of tractor by using cultivator and rotavator to get the fine tilth. Different agronomic practices were performed during the experiment from field preparation to harvesting. The planting was done at the spacing of 60 x 45 cm (row x plant). The 1st irrigation was given at the time of transplanting and next irrigation after a week. Subsequent irrigations were applied as per requirement throughout the growing season. The chillies were plucked from the plant with help of hand and was done manually 7 times. The green fruits with maturity were harvested.

Development studies of different plant parts during the growth period helped to explain the effect of various treatments on the final yield. Thus, to assess the effect of various treatments, different plant characters were studied as mentioned below: average plant height (cm), average stem diameter (mm), number of days taken for flower initiation, average length of fruit (cm), average diameter of fruit (mm), number of days taken for first picking, number of pickings per plant, single fruit weight, average number of fruits per plant, average fruit yield per plant (g), estimated fruit yield per hectare, total soluble solids (TSS), ascorbic acid content (mg/100g of fruit), capsaicin content (µ/g of dry matter) and economic analysis. The ascorbic acid content of fruit was calculated as per the guidelines of AOAC (Horwitz and Latimer, 2007). The capsaicin content in chilli was estimated as pungency by Scoville heat units and was quantified by using HPLC method (Popelka *et al.*, 2017). After considering the corresponding fixed inputs, the cost occurred on each treatment was worked out for one season. After computing the gross and net returns, the benefit –cost ratio (B: C) was calculated for each treatment combination.

Total cost of cultivation = Fixed cost + Variable cost

Gross return = (Selling price of the produce) x ha) – Cost of cultivation (Rs. per ha)

B:C Ratio = Net return (Rs. per ha) ÷ Cost of cultivation (Rs. per ha)

The observations taken for all parameters with two factors and three replications were statistically analysed by using OPSTAT software. Data were subjected to analysis of variance (ANOVA) at $P \leq 0.05$ according to Steel and Torrie (1980) while significant differences were detected, using mean separation as described by Waller and Duncan (1969).

Results and discussion

Plant growth: Among the various treatments, maximum plant height and average stem diameter was obtained in T_{10}, T_8 and T_9 (Table 1) while lowest was reported in T_1 for plant height and T_{11} for stem diameter. Among the two varieties, maximum plant height was reported in V_2 (Eagle-53) while maximum average stem diameter was observed in V_1 (CH-27). Thus, a significant variation was reported among various treatments and between the varieties for both the growth parameters. Further, the interaction among the various treatments and two varieties was also significant for growth related parameters and showed greater variation. The results confirmed the role of neem cake and vermicompost in combination with RDF as inorganic fertilizers to improve plant growth parameters by increasing the soil nutrients level and ensuring the consistent availability of nutrients in the rhizosphere of plants (Kumar *et al.*, 2020). The neem cake reduced sucking pests' incidence and induced the stress-free growth in plants (Giraddi and Verghese, 2007; Veena *et al.,* 2017) while vermicompost acted as a source of nutrients and improved moisture supply (Reddy *et al.*, 2017).

Number of days taken for flowering and fruiting: Among the various treatments, number of days taken for flower initiation was minimum (29-30) in T_3, T_5, T_4, T_8 and T_1 while it was delayed in

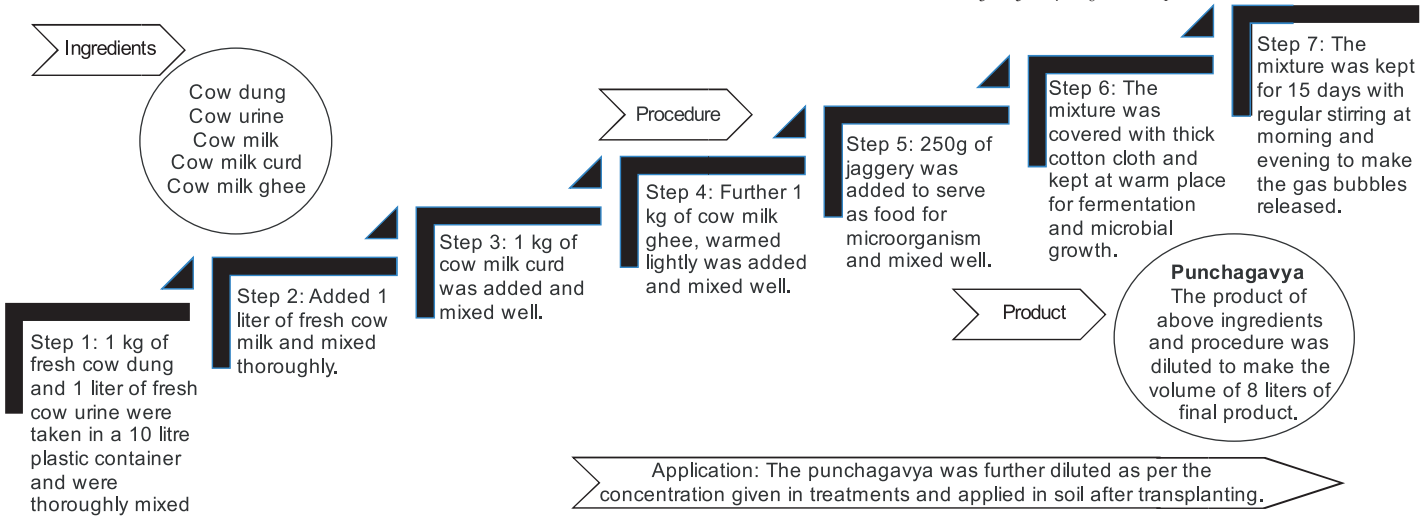

Fig. 1. Procedure used to make the punchagavya

Table 1. Plant growth of chilli varieties after application of different nutrient sources

Treatments	Plant height (cm)			Stem diameter (mm)		
	V_1 (CH-27)	V_2 (Eagle-53)	Mean	V_1 (CH-27)	V_2 (Eagle-53)	Mean
T_1	62.33	62.93	62.63^{h}	7.56	7.72	7.64^{c}
T_2	68.30	79.03	73.66^{e}	7.50	8.37	7.93^{bc}
T_3	82.66	67.03	74.85^{d}	8.67	6.47	7.57^{c}
T_4	67.06	66.36	66.71^{g}	7.14	8.39	7.77^{c}
T_5	56.66	77.13	66.90^{g}	8.37	7.98	8.18^{b}
T_6	44.83	66.70	55.76^{i}	6.78	9.21	7.99^{bc}
T_7	75.73	74.56	75.15^{d}	8.59	7.37	7.98^{bc}
T_8	87.26	82.50	84.88^{b}	8.59	8.43	8.51^{a}
T_9	86.03	76.53	81.28^{c}	8.47	8.04	8.25^{ab}
T_{10}	84.80	87.76	86.28^{a}	8.49	8.17	8.33^{ab}
T_{11}	78.36	56.40	67.38^{f}	7.98	6.06	7.02^{d}
Mean	72.18^{a}	72.45^{b}		8.01^{a}	7.84^{b}	
Factors	T	V	T x V	T	V	T x V
C.D. (P≤0.05)	0.46	0.20	0.66	0.32	0.10	0.46
SE(d)	0.23	0.09	0.32	0.16	0.06	0.22
SE(m)±	0.16	0.07	0.23	0.11	0.04	0.16

T_1-panchagavya @ 3%, T_2-vermicompost @ 1 ton per ha, T_3-neem cake @ 250 kg per ha, T_4-RDF @ 100:50:50 kg/ha, T_5-panchagavya @ 3% + vermicompost @ 1 ton per ha, T_6-panchagavya @ 3% + neem cake @ 250 kg per ha, T_7-panchagavya @ 3% + RDF 100:50:50 kg per ha, T_8-vermicompost @ 1 ton per ha + neem cake @ 250 kg per ha, T_9-vermicompost @ 1 ton per ha + RDF @ 100:50:50 kg per ha, T_{10}-neem cake @ 250 kg per ha + RDF @ 100:50:50 kg per ha, T_{11}-control

control (Table 2). Both the varieties have taken almost similar number of days for flowering with slight earliness in CH-27. The interaction among the various treatments and two varieties showed that early flowering was observed in T_3V_1 and T_5V_2 which were significantly better over the other treatments while the late flowering was reported in $T_{11}V_2$. The varietal variation might be due multiple resistant nature of CH-27 hybrid against many diseases and pests (Dhaliwal *et al.*, 2015) that leads to good growth of the plant. Application of neem cake had further reduced the incidence of sucking pests that helped in better plant growth and early transformation of vegetative phase to reproductive phase (Veena *et al.*, 2017).

Minimum number of days (63-66) taken for first picking was reported in T_1 followed by T_2 and T_{10} while the delayed picking was reported in T_8 (Table 2). The interaction among the various treatments and two varieties showed that T_1V_1 resulted in early first picking while the late picking was observed in T_7V_1. These results might be due to application of panchagavya which has beneficial effects owing to growth regulatory substances such as gibberellic acid (GA3), indole acetic acid (IAA), cytokinin and some essential plant nutrients which resulted in high amount of amino acid synthesis (proline leading to early fruiting (Shailaja *et al.*, 2014; Swain *et al.*, 2015).

Yield related attributes: Among the various treatments, longest fruit with maximum diameter was obtained in T_3 while minimum fruit length and diameter was obtained in T_6 (Table 3). Among the two varieties, V_2 (Eagle-53) resulted in maximum fruit length and diameter which may be the varietal attribute and better response of Eagle-53 for the given treatments. Further, the interaction among the various treatments and varieties was also significant for fruit

Table 2. Flowering and fruiting of chilli varieties after application of different nutrient sources

Treatments	Number of days to first flowering			Number of days to first picking		
	V_1 (CH-27)	V_2 (Eagle-53)	Mean	V_1 (CH-27)	V_2 (Eagle-53)	Mean
T_1	29.66	30.33	30.00^{cd}	61.00	66.00	63.50^{h}
T_2	30.66	30.00	30.33^{c}	65.00	64.00	64.50^{g}
T_3	27.00	31.00	29.00^{d}	64.00	71.00	67.50^{e}
T_4	30.33	29.66	30.00^{cd}	68.00	67.00	67.50^{e}
T_5	29.66	28.66	29.16^{d}	70.00	68.00	69.00^{b}
T_6	34.66	33.66	34.16^{a}	66.33	69.00	67.67^{e}
T_7	31.00	30.33	30.66^{c}	73.00	64.00	68.50^{c}
T_8	30.00	30.00	30.00^{cd}	70.00	70.33	70.17^{a}
T_9	31.33	32.66	32.00^{b}	70.00	68.67	69.34^{b}
T_{10}	31.00	32.33	31.66^{c}	70.00	62.00	66.00^{f}
T_{11}	32.33	36.66	34.50^{a}	66.00	70.00	68.00^{b}
Mean	30.69^{b}	31.39^{a}		67.58^{a}	67.27^{b}	
Factors	T	V	T x V	T	V	T x V
C.D. ($P \leq 0.05$)	1.10	0.47	1.56	0.25	0.10	0.35
SE(d)	0.54	0.23	0.77	0.12	0.05	0.17
SE(m)±	0.38	0.16	0.54	0.08	0.04	0.12

Treatment details are given below Table 1

Table 3. Average fruit size of chilli varieties after application of different nutrient sources

Treatments	Fruit length (cm)			Fruit diameter (mm)			Single fruit weight (g)			Number of fruits per plant		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	5.50	6.40	5.95^{c}	8.59	11.45	10.01^{d}	4.17	3.64	3.91^{c}	86.33	103.96	95.15^{d}
T_2	5.50	6.40	5.95^{c}	10.22	12.10	11.15^{c}	3.14	4.45	3.79^{e}	111.60	114.57	113.08^{a}
T_3	7.40	6.43	6.92^{a}	13.42	12.43	12.90^{a}	3.92	3.36	3.64^{d}	107.63	95.86	101.74^{bc}
T_4	5.40	7.43	6.42^{b}	11.73	12.56	12.14^{b}	3.65	4.38	4.01^{bc}	96.77	87.02	91.89^{de}
T_5	6.50	5.40	5.95^{c}	10.68	9.22	9.95^{d}	4.35	3.67	4.01^{bc}	89.37	96.70	93.03^{de}
T_6	4.33	4.46	4.40^{f}	6.48	10.52	8.50^{f}	3.17	4.49	3.83^{c}	87.20	84.93	86.07^{f}
T_7	5.93	4.80	5.36^{de}	12.43	10.42	11.42^{c}	3.73	4.20	3.97^{bc}	127.10	81.97	104.53^{b}
T_8	6.30	6.13	6.27^{b}	10.63	13.14	11.88^{b}	3.60	4.50	4.05^{b}	92.23	77.87	85.05^{f}
T_9	4.66	5.33	5.00^{e}	12.98	12.21	12.59^{a}	3.53	4.14	3.83^{c}	98.13	100.6	99.37^{c}
T_{10}	5.06	5.80	5.43^{d}	12.45	11.58	12.01^{b}	4.50	4.64	4.57^{a}	85.53	96.66	91.10^{e}
T_{11}	5.33	4.96	5.15^{e}	10.42	8.25	9.33^{e}	3.97	2.93	3.45^{e}	82.70	100.53	91.62^{e}
Mean	5.63^{b}	5.77^{a}		10.91^{b}	11.26^{a}		3.79	4.04^{a}		96.78^{a}	94.61^{b}	
Factors	T	V	T x V	T	V	T x V	T	V	T x V	T	V	T x V
C.D. ($P \leq 0.05$)	0.27	0.11	0.38	0.41	0.17	0.58	0.12	0.05	0.17	3.47	1.48	4.91
SE(d)	0.13	0.05	0.18	0.20	0.09	0.29	0.05	0.03	0.08	1.71	0.73	2.42
SE(m)±	0.09	0.04	0.13	0.14	0.06	0.20	0.04	0.02	0.06	1.21	0.52	1.71

Treatment details are given below Table 1

size and showed greater variation. These results might be due to application of neem cake which helped in controlling sucking pests and stimulated the important biochemical changes in the plant which helped in getting better average fruit size (Giraddi and Verghese**,** 2007; Veena *et al.*, 2017).

Among the various treatment, maximum single fruit weight was obtained in T_{10} (Table 4) followed by T_8, T_4 and T_5 while the maximum number of fruits per plant was obtained in T_2 followed by T_7 and T_3. Among the two varieties, the single fruit weight was superior in V_2 (Eagle-53) while maximum number of fruits per plant was observed in V_1 (CH-27). Further, the interaction among the various treatments and varieties was also significant for fruit yield related parameters. Application of inorganic fertilizers as source of nutrients played significant role to develop fruits with heavier weight and was responsible for higher fruit yield (Dubey *et al.*, 2017). The integrated application of organic manures along with inorganic fertilizers resulted in good yield attributes due to regular nutrient availability from organic and inorganic sources (Altaf *et al.*, 2019). Further, application of vermicompost helped in increasing number of fruits per plant due to the influence of the growth promoting substances released from vermicompost which improved the soil quality and the fruit set (Ankaram, 2013; Kumar *et al.*, 2016; Vijayalakshmi and Gayathri, 2017; Reddy *et al.*, 2017).

Average yield of chilli fruits: Among the various treatments, the highest fruit yield was obtained in T_8 followed by T_1 and T_4 while minimum was obtained in control (Table 5). Among the varieties, V_1 (CH-27) resulted in maximum fruit yield as compared to V_2 (Eagle-53). Further, the interaction among the treatments and varieties was also significant for fruit yield

Table 4. Yield related attributes of chilli varieties after application of different nutrient sources

Treatments	Single fruit weight (g)			Number of fruits per plant		
	V_1 (CH-27)	V_2 (Eagle-53)	Mean	V_1 (CH-27)	V_2 (Eagle-53)	Mean
T_1	4.17	3.64	3.91^{c}	86.33	103.96	95.15^{d}
T_2	3.14	4.45	3.79^{c}	111.60	114.57	113.08^{a}
T_3	3.92	3.36	3.64^{d}	107.63	95.86	101.74^{bc}
T_4	3.65	4.38	4.01^{bc}	96.77	87.02	91.89^{de}
T_5	4.35	3.67	4.01^{bc}	89.37	96.70	93.03^{de}
T_6	3.17	4.49	3.83^{c}	87.20	84.93	86.07^{f}
T_7	3.73	4.20	3.97^{bc}	127.10	81.97	104.53^{b}
T_8	3.60	4.50	4.05^{b}	92.23	77.87	85.05^{f}
T_9	3.53	4.14	3.83^{c}	98.13	100.6	99.37^{c}
T_{10}	4.50	4.64	4.57^{a}	85.53	96.66	91.10^{e}
T_{11}	3.97	2.93	3.45^{e}	82.70	100.53	91.62^{e}
Mean	3.79	4.04^{a}		96.78^{a}	94.61^{b}	
Factors	T	V	T x V	T	V	T x V
C.D. (P≤0.05)	0.12	0.05	0.17	3.47	1.48	4.91
SE(d)	0.05	0.03	0.08	1.71	0.73	2.42
SE(m)±	0.04	0.02	0.06	1.21	0.52	1.71

Treatment details are given below Table 1

and showed greater variation. These results might be due to application of vermicompost, neem cake and panchagavya where the vermicompost helped in increasing beneficial microbes and mineralization of organic matter (Ankaram, 2013) leading to increased fruit yield (Rao *et al*., 2015), neem cake helped to control insect-pest attack during fruit development and maturity resulting greater number of large size fruits and was useful to maintain plant health (Varghese and Giraddi, 2005) while panchagavya improved the size of fruits. Further, these organic sources contain good amount of nitrogen along with macro and micronutrients which enhanced the microbial activity leading to high yield (Lallawmkima *et al.*, 2018; Singh *et al.*, 2018). Moreover, CH-27 variety is highly resistant to disease and insects which helped to obtain high yield (Dhaliwal *et al*., 2015).

Fruit quality of chilli: Maximum total soluble solids was obtained in T_9, the maximum ascorbic acid content was estimated T_1 while the maximum (0.46 µg/g of dry matter) capsaicin content was obtained in T_6 (Table 6). Among the different varieties, V_1 (CH-27) resulted in maximum total soluble solids and ascorbic acid content while V_2 (Eagle-53) was estimated with maximum capsaicin content. The interaction among treatments and varieties was also significant for fruit quality related traits. The application of vermicompost in combination with the inorganic sources might have improved the physio-chemical and biological properties of soil resulting improved fruit quality (Kashyap *et al.*, 2014; Atlaf *et al.*, 2019). Furthermore panchagavya has ability to supply growth promoting substances and nutrients which enhanced ascorbic acid content of chilli fruits as also reported by Shailaja *et al.* (2014) and Madhukumar *et al.* (2018).

Economic analysis of chilli cultivation: The estimates of economic analysis of chilli per ha (Table 7) revealed that the variation in cost was due to the cost of nutrient sources and under combined application of organic sources it was higher as compared to recommended dose of fertilizers. The highest gross income, net income, and B:C ratio from one hectare was recorded in T_8V_1, closely followed by T_4V_1 and T_5V_1 while minimum was

Table 5. Yield of chilli varieties after application of differnt nutrient sources

Treatments	Fruit yield (g /plant)			Estimated yield (q per ha)		
	V_1	V_2	Mean	V_1	V_2	Mean
T_1	381.37	474.00	427.68^{b}	141.24	175.55	158.38^{b}
T_2	344.23	329.33	336.78^{g}	127.48	136.26	131.87^{d}
T_3	350.50	346.53	348.52^{f}	129.80	128.33	129.07^{de}
T_4	416.33	385.00	400.67^{c}	154.19	142.59	148.39^{c}
T_5	448.33	328.17	388.25^{d}	166.04	121.54	143.79^{c}
T_6	294.50	359.66	327.08^{h}	130.38	133.21	131.79^{d}
T_7	378.80	350.57	364.68^{e}	140.18	129.83	135.00^{d}
T_8	509.77	421.70	465.73^{a}	188.76	156.17	172.46^{a}
T_9	321.77	353.40	337.58^{g}	119.16	130.88	125.03^{e}
T_{10}	381.17	387.87	384.52^{d}	141.16	143.65	142.49^{c}
T_{11}	352.03	276.17	314.10^{i}	109.06	102.28	105.67^{f}
Mean	379.89^{a}	364.76^{b}		140.68^{a}	136.39^{b}	
Factors	T	V	T x V	T	V	T x V
C.D. ($P \leq 0.05$)	6.53	2.78	9.23	6.69	2.85	9.46
SE(d)	3.22	1.38	4.56	3.30	1.41	4.67
SE(m)±	2.28	0.97	3.22	2.34	0.97	3.30

Treatment details are given below Table 1

Table 6. Fruit quality of chilli varieties after application of different nutrient sources

Treatments	TSS (ºBrix)			Ascorbic acid (mg per 100 g)			Capsaicin (µg per g)		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	4.50	3.53	4.02^{f}	88.10	82.63	85.37^{a}	0.10	0.17	0.14^{d}
T_2	5.38	4.33	4.85^{d}	53.50	72.57	63.03^{d}	0.34	0.34	0.34^{b}
T_3	5.23	4.80	5.02^{c}	53.63	63.63	58.63^{e}	0.12	0.22	0.17^{cd}
T_4	5.20	5.30	5.25^{b}	45.60	59.60	52.60^{i}	0.31	0.14	0.22^{cd}
T_5	4.50	5.30	4.90^{cd}	85.13	67.53	76.33^{b}	0.33	0.13	0.23^{c}
T_6	3.30	5.27	4.28^{e}	54.43	85.37	69.90^{c}	0.08	0.83	0.46^{a}
T_7	5.43	4.60	5.02^{c}	71.47	43.70	57.58^{f}	0.16	0.23	0.20^{cd}
T_8	5.60	4.47	5.03^{c}	67.50	44.50	56.00^{h}	0.20	0.67	0.43^{a}
T_9	5.50	5.33	5.42^{a}	56.70	57.63	57.17^{f}	0.20	0.23	0.21^{cd}
T_{10}	4.60	5.23	4.92^{cd}	73.67	65.63	69.65^{c}	0.13	0.23	0.18^{cd}
T_{11}	5.60	4.30	4.95^{cd}	66.40	46.80	56.60^{g}	0.14	0.01	0.08^{d}
Mean	4.99^{a}	4.78^{b}		65.10^{a}	62.69^{b}		0.19^{b}	0.29^{a}	
Factors	T	V	T x V	T	V	T x V	T	V	T x V
C.D. ($P \leq 0.05$)	0.14	0.06	0.19	0.48	0.20	0.68	0.08	0.04	0.12
SE(d)	0.07	0.03	0.010	0.23	0.10	0.33	0.04	0.02	0.06
SE(m)±	0.05	0.02	0.07	0.17	0.07	0.24	0.03	0.01	0.04

Treatment details are given below Table 1

estimated in $T_{11}V_1$ for cultivar CH-27. However, for cultivar Eagle-53, the better economic response was found in T_1V_2 while minimum was in $T_{11}V_2$. Although, the cost of cultivation was high for such treatments, the gross and net income was also greater with high B:C ratio due to higher yield. This can be further attributed with good quality fruits. Application of RDF was also reported to have better contribution towards higher net income in different treatments (T_4) due to greater influence over yield (Hasan *et al.*, 2019).

Based on present study, it can be concluded that the two varieties (CH-27 and Eagle-53) showed slight variation for all parameters investigated. However, the CH-27 gave better yield, quality, and income response for most of the treatments. Among different treatments, vermicompost @ 1 ton/ha + neem cake @ 250 kg/ha gave better yield and B:C ratio. In both the varieties, application of RDF was second best treatment. Application of panchagavya proved to be more effective for improvement in quality parameters.

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Table 7. Economic analysis of chilli cultivation after application of different nutrient sources

Treatments	V_1 (CH-27)				V_2 (Eagle-53)			
	Total cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	Benefit cost ratio (B:C)	Total cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	Benefit cost ratio (B:C)
T_1	83430	367231	283801	3.40	83430	403765	320335	3.83
T_2	84680	331448	246768	2.91	84680	313398	228718	2.70
T_3	77930	259550	259550	3.33	77930	295165	217235	2.78
T_4	81730	400894	319164	3.90	81730	327957	246227	3.01
T_5	93430	431711	338281	3.62	93430	279452	186112	1.99
T_6	89680	338988	249308	2.77	89680	306360	216680	2.41
T_7	90480	364460	273980	3.02	90480	298615	208135	2.30
T_8	90930	490768	399838	4.39	90930	359191	268231	2.95
T_9	91730	309823	218093	2.37	91730	31040	209310	2.28
T_{10}	87980	367034	279054	3.17	87980	330395	242415	2.75
T_{11}	74680	163600	88920	1.19	74680	153420	78740	1.05

Treatment details are given below Table 1

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