Original Research Article

Economic Analysis of Organic Bell Pepper (*Capsicum annuum* L.) Production under Mid Hill Condition of Himachal Pradesh

ABSTRACT

The field experiment 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 in order to study economic analysis of organic bell pepper (*Capsicum annuum* L.) production. The experiment was laid out in Randomized Complete Block Design (RCBD) Factorial with three replications comprising of ten treatment combinations. The study divulged that vermicompost @ 7 t/ha + Jeevamrut (Drenching @ 5 % + Foliar spray @ 3 %) significantly influenced yield and yield contributing traits of bell pepper 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) along with highest gross income (₹ 916,050.00/ha) and net return (₹ 713,795.00/ha) whereas B: C ratio (5.43) was obtained highest with No organic manure + Jeevamrut (Drenching @ 5 % + Foliar spray @ 3 %). Hence, Jeevamrut (Drenching @ 5 % + Foliar spray @ 3 %) application from economic point of view and Vermicompost @ 7 t/ha along with Jeevamrut (Drenching @ 5 % + Foliar spray @ 3 %) for getting high yield can be recommended for commercial cultivation.

Key words: Organic manure, Liquid manure, Economics, Yield, Bell Pepper

1. INTRODUCTION

Bell pepper (*Capsicum annuum* L. var. *grossum* Sendt.) belongs to family Solanaceae, chromosome number 2n = 24, commonly known as sweet pepper, capsicum and Shimla mirch. It is native of Mexico with secondary centre of origin in Guatemala (Bukasov, 1930). It is the world's second most important vegetable crop after tomato and is relatively non-pungent or slightly pungent with thick flesh. Bell pepper has a low energy content, although it is high in nutrients, particularly vitamin A and vitamin C (Raturi *et al*., 2019). Organic agriculture has the potential to enhance soil fertility, biodiversity and economic performance (Hameedi *et al*., 2018). Organic agriculture is gaining popularity, and organic food markets are fast developing in many nations, including India (Gopinath *et al*., 2011). Organic manure can be applied as counterfeit practice to inorganic fertilizers (Naeem *et al*., 2006). The excessive use of inorganic fertilizers caused series of problems among which soil degradation, poor quality production, environmental pollution and some serious hazards to human health are the most common. Application of inorganic fertilizers can only supply one or two nutrient elements. Organic manure act out a key role in plant growth as an origin of all essential macro and micronutrients in easily available forms during mineralization (Nweke *et al*., 2013) and soil physical and chemical properties are improved (Chaterjee *et al*., 2005). So, high yield, high gross income and net return can be obtained by the application of manures.

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 and Benefit: Cost (BC) ratios were recorded. The data recorded on various parameters were analyzed for RBD design as suggested by (Gomez and Gomez, 1983). The results have been interpreted on the basis of 'F' test value and critical difference (CD) was calculated 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 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.

2.2 Economics of treatments

The economics of treatment is the most important consideration for making any recommendation to the farmer for its adoption. The cost of bell pepper production under different treatments was studied to work out economics of various sources of organic nutrients considering the present price of inputs and produce, gross return was worked out on the basis of market price of the produce at the time when the produce was ready for sale. Net returns and benefit cost ratios were worked out for each nutrient treatment by adopting the following formulae:

Net return (₹/ha) = Gross returns (₹/ha) - Cost of cultivation (₹/ha)

Benefit: Cost ratio = Net return (₹/ha) /Cost of cultivation (₹/ha)

3. Result and discussion

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/ha (322.47 q) and minimum was observed in plots where no manure (M_0) was applied.

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/ha (299.26 q) as compared with L_0 (No liquid manure).The effect of Jeevamrut as well as its interaction with other levels of organic manure was found to be non-significant on fruit length (cm).

The interactions of both the factors 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/ha (366.42 q), was observed in M_2L_1 and minimum of all these characters were recorded in M_0L_0.

It could be due to vermicompost application, which has a direct effect on plant growth, providing a source of plant macro and micronutrients. Although some of these nutrients exist in inorganic forms and are quickly available to plants, the majority are released gradually through mineralization of organic materials, resulting in a gradual-release fertilizer that provides a dynamic and steady source of nutrients to the plant. These results are also supported by findings of (Arancon *et al*., 2003), Arancon *et al*. (2005), (Natesh *et al*., 2005), (Joshi and Pal Vig, 2010), (Ramesh *et al*., 2015), (Kumar, 2016) and (Ahmed *et al*., 2017).

Economics of the treatment

The economics of the various treatment combinations have been presented in Table 2. A perusal of data revealed that highest cost of production Rs. 202,255.00 was incurred in M_2L_1, whereas lowest (₹ 94,030.00) was observed in M_0L_0. Similarly maximum gross income per hectare amounting to ₹ 916,050.00 was obtained in M_2L_1 followed by M_1L_1 (₹ 787,650.00), while minimum gross income (₹ 502,225.00) was recorded in M_0L_0. This is due to the high cost of production and maximum marketable yield in M_2L_1 as compared to other treatments used in the study. However, highest net return (₹ 713,795.00) was recorded in M_2L_1 followed by M_1L_1 (₹ 652,695.00) and lowest net return (₹ 408,195.00) was observed in M_0L_0. In overall, maximum B: C ratio (5.43) was recorded in M_0L_1 followed by B: C ratio (4.84) in M_1L_1, whereas minimum B: C ratio (2.48) was calculated in M_2L_0, which may be due to the lower cost of production and comparable gross income in M_2L_1. Hence the application of M_0L_1 (No manure + Jeevamrut) rated as the most economic treatment for bell pepper production under mid hill conditions of Himachal Pradesh.

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. Economics of the bell pepper production as affected by different treatments.

Treatments	Fruit yield q/ha	Gross income (₹/ha)	Total cost of production (₹/ha)	Net return (₹/ha)	Benefit Cost Ratio
M_0L_0	200.89	502,225.00	94,030.00	408,195.00	4.34
M_1L_0	277.04	692,600.00	132,830.00	559,770.00	4.21
M_2L_0	278.52	696,300.00	200,130.00	496,170.00	2.48
M_3L_0	275.06	687,650.00	166,480.00	521,170.00	3.13
M_4L_0	265.19	662,975.00	149,655.00	513,320.00	3.43
M_0L_1	247.41	618,525.00	96,155.00	522,370.00	5.43
M_1L_1	315.06	787,650.00	134,955.00	652,695.00	4.84
M_2L_1	366.42	916,050.00	202,255.00	713,795.00	3.53
M_3L_1	294.32	735,800.00	168,605.00	567,195.00	3.36
M_4L_1	273.09	682,725.00	151,780.00	530,945.00	3.50

4. CONCLUSION

From the present studies, it can be concluded that combined application of Vermicompost + Jeevamrut shown best result for most of the yield and yield contributing traits. It also resulted in highest gross income (₹ 916,050.00/ha) and net return (₹ 713,795.00/ha), whereas highest benefit cost ratio (5.43) was obtained from M_0L_1 (No organic manure + Jeevamrut) Therefore, on the basis of results obtained in present studies, application of Jeevamrut (Drenching @ 5 % + Foliar spray @ 3 %) from economic point of view can be recommended for organic cultivation of bell pepper, as it resulted in getting maximum B: C ratio (5.43). On the other hand, application of vermicompost @ 7 t/ha along with Jeevamrut (Drenching @ 5 % + Foliar spray @ 3 %) should be recommended for getting higher yield & sustainable crop production point of view. Further, if the farmer produces vermicompost on farm, definitely it will reduce the cost of cultivation incurred for getting better yield and sustainable crop production & good economic return as well.

5. References

1. Ahmed, N., Rameshwar., Sini, J.P., Sharma, R.P, Punam. and Seth, M. (2017). Performance of chickpea under organic and inorganic sources of nutrients at different soil moisture regimes in chickpea-okra cropping system. Himachal Journal of Agricultural Research, 43: 23-28.

2. Arancon, N. Q., Edward, C. A., Biermanb, P., Metzgerc, J. D. and Lucht, C. (2005). Effects of vermicompost produced from cattle manure, food waste and paper waste on the growth and yield of peppers in the field. *Pedobiologia,* **49**:297-306
3. Arancon, N. Q., Edwards, C. A., Bierman, P., James, D. M., Stephen, L. and Christie, W. (2003). Effects of vermicomposts on growth and marketable fruits of field-grown tomatoes, peppers and strawberries. *Pedobiologia,* **47**:731-735
4. Hameedi, A., Thakur, K. S., Sharma, U., Yousafzai, A., Mohammadi, M. H., Durrani, H. and Durani, A. (2018). 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. *International Journal of Chemical Studies*, **6**(1): 1913-1917
5. Bukasov, S. M. (1930). The cultivated plants of Mexico, Guatemala and Columbia. Instituta Rastenievodostva Vaskhnil, Leningrad, 553p.
6. Chaterjee, B., Ghanti, P., Thapa, U. and Tripathy, P. (2005). Effect of organic nutrition in sprouting broccoli. *Vegetable Science,* **33**(1): 51-54
7. Gomez, A. A. and Gomez, A. A. (1984). Statistical Procedures for Agricultural Research. John Wiley and Sons. New York, 680p.
8. Gopinath, K. A., Saha, S., and Mina, B. L. (2011). Effects of organic amendments on productivity and profitability of bell pepper–french bean–garden pea system and on oil properties during transition to organic production. *Communications in Soil Science and Plant Analysis,* **42**:2572-2585
9. Joshi, R. and Pal Vig, A. (2010). Effect of vermicompost on growth, yield and quality of tomato (*Lycopersicum esculentum* L). *African Journal of Basic & Applied Sciences,* **2**(3-4):117-123
10. Kumar, B. M. (2016). Effect of vermicompost on germination, growth and yield of vegetable plants. *Scrutiny International Research Journal of Agriculture, Plant Biotechnology and Bio Products,* **3**(1): 07-13
11. Naeem, M., Iqbal, J. and Bakhsh, M. A. A. (2006). Comparative study of inorganic fertilizers and organic manures on yield and yield components of Mungbean. Journal of Agriculture & Social Sciences, **2**(4): 227-239
12. Natesh, N., Vyakaranahal, B. S., Shekhargouda, M. and Deshpande, V. K. (2005). Effect of micronutrients and organics on growth, seed yield and quality of chilli. *Karnataka Journal Agricultural Sciences,* **18**(2): 334-337
13. Nweke, I. A., Ijearu, S. I. and Igili, D. N. (2013). Effect of different sources of animal wastes on the growth and yield of okra (*Abelmoschus esculentus* L.Moench) in Ustoxic Dystropept at Enugu South Eastern, Nigeria. *International Journal of Scientific and Technology Research,* **2**(3): 135-137

14. Ramesh, G., Ajithkumar, K., Savitha, A. S. and Patil, S. G. (2015). Integrated influence of organic manures in addition to inorganic fertilizers on growth, yield parameters and early blight disease of tomato (*Lycopersicon esculentum* L.). *International Journal of Biological & Pharmaceutical Research,* **6**(6): 478-483
15. Raturi, H. C., Uppal, G. S., Singh, S. K. and Kachwaya, D. S. (2019). Effect of organic and inorganic nutrient sources on growth, yield and quality of bell pepper (*Capsicum annuum* L.) grown under polyhouse condition. *Journal of Pharmacognosy and Phytochemistry*, **8**(1): 1788-1792