Vegetable Science (2020) 47 (1) : 142-145

Short Communication

Evaluation of soilless growing media for cost effective production of coloured capsicum under protected conditions

RS Spehia*[a], Nidhi[b], Meera Devi[a] and DK Mehta[b]

Received: May 2020 / Accepted: June 2020

Capsicum or bell pepper (*Capsicum annuum* L.) is produced world over and its area coverage combined with chilli is 1.5 million ha with output of 19.0 million tons (Anonymous 2020). In India, the area coverage is 46.0 thousand ha with a production of 326.0 thousand tons (Anonymous 2019). It is an important crop of open fields, but with advent and popularization of greenhouse technology, it has occupied top place under protected conditions. Bell pepper has potential to improve the economy of farmers grown as an offseason crop and has good export value. Though, soil of uniform texture is the least expensive medium for plant growth, but soil does not always occur in perfect package. When adverse conditions are found in soil and reclamation is impractical, the need of soilless culture is justified. Soilless culture offers an alternative to soil culture when serious soil and water problems (i.e., soil born pests, soil and water salinity, chemical residues in soil, water salinity, lack of fertile soil, water shortage), create difficulties in traditional soil-based production. The main advantages of soilless culture are the increased productivity due to easier and more accurate control of production factors such as water and nutrients, reduction of labour requirement, no need for sterilization, more crops per year etc. (Tuzel et al. 2008). At present, bell pepper growers are facing several challenges in the open field cultivation due to vagaries of weather viz. fluctuating temperature, unprecedented rains and frequent hailstorms which affect the yield and quality of the produce, thereby reducing the profit margin. Due to these challenges, protected cultivation is getting preference over open field cultivation by extending availability of the quality produce, higher productivity and improved nutritional attributes of the produce. Protected cultivation can make small holdings viable by producing maximum from limited land, overcoming vagaries of nature and diversification of high value vegetable crops. It can also stabilize production system in addition to quality improvement through utilization of vertical space and precision farming. Further, these structures can facilitate crop production in areas where vegetable production during extreme weather conditions is not possible. At present, protected cultivation is practiced in an area of 3052.6 thousand ha world over with India having 1908 ha area (Spehia and Upadhyay 2017). However, under protected conditions, farmers in order to grow best commercial crop, generally follow monoculture which leads to deterioration in soil health. The best remedy for poor soil health, therefore, is crop production under soilless media. The soilless crops are mainly grown in the greenhouse and require precise technology, considerable capital investment and adequate professional skills on the part of the operator. Nevertheless, they are highly productive and ergonomic, they use water and space efficiently and in closed loop systems, prevent the pollution of soil and groundwater. Soilless media, i.e., cocopeat, vermicompost, sand, vermiculite and others are the alternatives to problem soils for crop production. Organic concoctions such as jeevamrut contain macro-nutrients, micro-nutrients, vitamins, amino acids, IAA, GA and beneficial microorganisms which help improve higher growth, yield and quality of crops (Sreenivasa et al., 2010). The standardization of best media, therefore, may help in recommending the same to the farmers which will further improve economic viability of producing capsicum under protected cultivation.

The experiment was conducted for consecutive years during 2016 and 2017 at the Research Experimental Farm

[a]Department of Soil Science and Water Management, Dr. Y.S. Parmar University of Horticulture and Forestry, Solan-173 230, Himachal Pradesh
[b]Department of Vegetable Science, Dr. Y.S. Parmar University of Horticulture and Forestry, Solan-173 230, Himachal Pradesh
*Corresponding author, Email: rsspehia.33044@gmail.com

of the Precision Farming Development Centre, Department of Soil Science and Water Management, Dr Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (HP), India situated at 30°52' North Latitude and 77°11' East longitude at 1260 m above mean sea level with average slope of 7-8% in the mid hill zone of Himachal Pradesh. The area receives 1115 mm average annual rainfall, with about 75% received during mid-June to mid-September. Seeds of Orobelle (hybrid of Syngenta, purchased from market) were sown in plug trays (126 holes) in a soilless medium in a greenhouse and the seedlings were transplanted in March during both the years. Each UV stabilized growbag contained only one plant. Equal amount of irrigation and fertigation were applied through drip system. The treatments comprising of growing media, and their combinations, replicated three times, were, T_1: cocopeat (control); T_2 : cocopeat+vermicompost (70:30 v:v)+ jeevamrut as foliar application @ 5% ; T_3 : cocopeat+jeevamrut as foliar application @ 5%; T_4: vermiculite ; T_5 : vermiculite+vermicompost (70:30 v:v)+Jeevamrut as foliar application @ 5%; T_6: vermiculite+jeevamrut as foliar application @ 5%; T_7 :Sand ; T_8 : sand+vermicompost (70:30 v:v)+ Jeevamrut as foliar application @ 5%, and T_9: sand+Jeevamrut as foliar application @ 5%. Jeevamrut was prepared by mixing cow dung (10 kg), cow urine (10 L), jaggery (2 kg), pulse floor (2 kg), soil (1 hand full) and water (200 L) in the ratio used by Devakumar et al. (2014). Jeevamrut @ 5% was applied to foliage at a 15-day interval. Phosphorus and potassium analysis in media before and after termination of experiment was done as per Piper (1966) and N analysis was done as per Jackson (1973). The pH and electrical conductivity (EC) (1:2 soilless medium: water suspension) was with a digital pH and EC meter, respectively. The benefit-cost ratio was calculated by considering the variable cost and fixed inputs along with average selling price of produce at the prevailing market rate of Rs. 90 kg^{-1}.

Initial pH, EC and nutrient content of popular growing media viz. cocopeat, vermiculite and sand along with mixers like vermicompost and jeevamrut are presented in Table 1. Minimum pH was recorded under cocopeat (6.23) while maximum (7.03) was recorded under vermicompost while EC was lowest under vermiculite (0.148 dS m^{-1}) and maximum under jeevamrut (3.04 dS m^{-1}). Available Nitrogen (0.0014%), phosphorus (0.0004%) and potassium (0.0061%) content were lowest under vermiculite while vermicompost recorded maximum N (1.71%), P (1.20%) and K (1.01%) content. After completion of the experiment (Table 2), the corresponding pH under different treatments revealed that pH was maximum under T_8 (6.94) having sand as main growing media while treatment T_1 having cocopeat as main growing media recorded minimum pH (6.35). Similarly, EC was recorded maximum under T_8 (0.68 dS m^{-1}) while treatment T_4 recorded minimum EC (0.25 dS m^{-1}). Available N (0.657%), P (0.562%) and K (0.823%) content were recorded maximum under treatment T_8 while minimum available N (0.002%), P (0.001%) and K (0.007%) were recorded under treatment having vermiculite as main growing media (Table 2). The appreciable increase in pH, EC and available nutrients may be attributed to addition of vermicompost to the main growing media as well as nutrients supplied through fertigation.

Maximum plant height (119.50 cm), number of fruits per plant (25.67), average fruit weight (207.43 g), fruit yield per plant (5.32 kg) and harvest duration (99.67 days) along with minimum days to 50 per cent flowering (40.50 days) and days to marketable maturity (69.17 days) were recorded under the treatment T_8 (Sand + Vermicompost (70:30 v/v) + Jeevamrut (5% foliar spray)), whereas, maximum days to 50 per cent flowering (53.17 days), days to marketable maturity (91.50 days), with minimum plant height (79.67 cm), number of fruits per plant (18.50), average fruit weight (157.27 g), fruit yield per plant (2.91 Kg/plant) and harvest duration (81.00 days) were recorded under treatment T_1 (Cocopeat), irrespective of the years (Table

Table 1: Initial status of components of growing medium prior to the experiment.

Parameter	Cocopeat	Vermiculite	Vermicompost	Jeevamrut	Sand
pH	6.23	6.65	7.03	7.01	6.79
EC (dS m^{-1})	0.21	0.148	0.628	3.40	0.418
N (%)	0.03	0.0014	1.71	0.077	0.30
P (%)	0.028	0.0004	1.20	0.166	0.24
K (%)	0.04	0.0061	1.01	0.126	0.21

Table 2: Effect of different treatments on pH, EC, N,P and K content of growing media

Treatment	pH	Electrical conductivity (dS m^{-1})	Nitrogen (%)	Phosphorus (%)	Potassium (%)
T_1	6.35	0.26	0.038	0.031	0.052
T_2	6.71	0.48	0.056	0.047	0.100
T_3	6.35	0.27	0.039	0.036	0.056
T_4	6.74	0.25	0.002	0.001	0.007
T_5	6.82	0.49	0.006	0.002	0.009
T_6	6.76	0.29	0.002	0.001	0.007
T_7	6.84	0.53	0.348	0.283	0.235
T_8	6.94	0.68	0.657	0.562	0.823
T_9	6.86	0.51	0.390	0.298	0.247
$CD_{0.05}$					
T	0.03	0.018	0.008	0.012	0.011
Y	0.01	0.008	0.004	0.006	0.005
T×Y	NS	NS	0.012	0.018	0.015

Table 3. Effect of growing media on plant growth parameters and economics of capsicum.

Treatment	Plant height (cm)	Days to 50% flowering	Days to marketable maturity	Number fruit per plant	Average fruit weight (g)	Fruit yield (kg/plant)	Harvest duration (days)	Total cost of cultivation/ bag (variable+ fixed cost)	Gross income (Rs./bag)	Net return (Rs./bag)	BC ratio (per bag)
T_1	79.67	53.17	91.50	18.50	157.27	2.91	81.00	151.07	261.9	110.83	0.73:1
T_2	83.17	48.67	84.50	22.17	168.88	3.74	84.67	148.94	336.6	187.66	1.26:1
T_3	81.50	51.83	85.17	19.17	165.90	3.18	82.50	151.12	286.2	135.08	1.47:1
T_4	95.50	49.50	82.17	19.17	160.30	3.07	89.33	451.07	276.3	-174.77	-0.39:1
T_5	100.17	43.83	70.00	25.00	183.13	4.59	90.00	352.12	413.1	60.98	0.17:1
T_6	98.00	47.33	77.00	21.83	169.72	3.71	85.17	451.12	333.9	-117.22	-0.26:1
T_7	111.67	44.17	73.17	22.33	201.79	4.51	96.00	121.07	405.9	284.83	2.35:1
T_8	119.50	40.50	69.17	25.67	207.43	5.32	99.67	133.46	478.8	345.34	2.59:1
T_9	115.67	42.00	72.17	22.83	203.59	4.65	97.17	121.12	418.5	297.38	2.45:1
Treatment (T)	2.07	2.19	2.10	1.54	2.61	0.29	1.69				
Year (Y)	0.98	NS	NS	NS	NS	0.14	0.79				
TxY	NS	NS	NS	NS	NS	NS	2.38				

3). The results obtained indicate that addition of organic compositions of vermicompost alongwith jeevamrut had significant effect and recorded better results as compared to other growing media containing only cocopeat, vermiculite or sand. This is due to the presence of higher amount of N, P and K initially in vermicompost as compared to other growing media. Since, all early flowering treatments have sand or vermicompost along with spray of jeevamrut (@ 5%) as a major component of growing media so, it is concluded that early flowering have occurred because of better uptake of nutrients leading to faster growth of plants in sand, vermicompost and jeevamrut treatments. Nagaraj et al. (2015) also reported highest growth and yield of capsicum in sandy loam soil. The increase in fruit weight is attributed mainly to availability of nutrients supplied through vermicompost and jeevamrut which had an added effect on more nutrients already available in sand as compared to other growing media. Boraiah et al. (2017) concluded that among different organic liquid formulations, application of jeevamrutha recorded significantly higher fruit yield on growth and yield of capsicum. Since, treatment T_8 also recorded lesser number of days to first flowering coupled with earliness to marketable maturity, hence longer harvest duration was achieved. The highest gross income (Rs 478.8/bag), net returns (Rs 345.34/bag) and benefit cost ratio (2.59:1/bag) was worked out in the treatment T_8 (Sand + Vermicompost (70:30 v/v) + Jeevamrut (5% foliar spray)) which was rated as the most profitable (Table 3) and cost effective followed by treatment T_9 (2.45:1/bag). The B:C ratio for vermiculite containing media is very less, even negative, because of more volume needed per bag and also due to higher cost as compared to sand (Table 3).

Based on the results obtained in present studies, inference can be drawn that sand + vermicompost (70:30 v/v) alongwith foliar spray of Jeevamrut @ 5% has great potential for use as a growing media for improving growth, quality, yield and yield attributing characters of coloured capsicum as growing conditions can be moderated according to the requirement. Moreover, all the components of the best media above referred contains sand, jeevamrut and vermicompost which are easily available, can be prepared by the farmer himself and is cheap even when purchased. Under protected cultivation, as soil is difficult to replace or replenish, soilless media containing locally available material is the best option. Moreover, it can be used for atleast three years before requiring replacement. Thus, substrate culture (Sand + Vermicompost (70:30 v/v) + Jeevamrut (5% foliar spray)) can be recommended for successful production of coloured capsicum under polyhouse condition.

Acknowledgement

The authors are thankful to Precision Farming Development Centre, Solan and National Committee on Plasticulture Applications in Horticulture, Department of Agriculture and Cooperation, Ministry of Agriculture and Farmers' Welfare, Government of India for supporting the study.

References

Anonymous (2020) Food and Agriculture Organization of the United Nations.www.fao.org › land-water › databases-and-software › crop-information (accessed on 12.4.2020)

Anonymous (2020) National Horticulture Board, India. http://apeda.in/agriexchange/India%20Production/India_Productions.aspx?hscode=1072 (accessed on 12.4.2020)

Boraiah B, Devakumar N, Subha S and Palanna KB (2017) Effect of panchagavya, jeevamrutha and cow urine on beneficial microorganisms and yield of capsicum (*Capsicum annuum* L. var. grossum). Int J Curr Microbiol App Sci 6:3226-3234.

Devakumar N, Subha S, Gouder SB and Rao GG (2014) Microbial analytical studies of traditional organic preparations: Beejamrutha and Jeevamrutha. In: Proceedings 4th ISOFAR Scientific Conference, Organic World Congress, 13-15 October 2014, Istanbul, Turkey.

Jackson ML (1973) Soil chemical analysis. Prentice Hall, Pvt. Ltd., New Delhi, pp 378.

Nagraj JD, Namichandarappa M, Kavita K, Vasantgouda R and Rudragouda SC (2015) Effect of different growing media on quality, growth, yield of bell pepper (*Capsicum annuum* var. *grossum*) under shade house conditions. Int J Agric Sci Res 5(4):277-284.

Piper CS (1966) Soil and Plant Analysis, Hans Pub., Bombay, India, pp 42-49.

Spehia RS and Upadhyay GP (2017) Protected cultivation-Sustained production under changing climate. In: Spehia RS and Upadhyay GP (ed) Precision Farming and Climate Change: Imperatives of Indian Agriculture, Bishen Singh Mahendra Pal Singh, Dehradun, pp 216.

Sreenivasa MN, Nagaraj MN and Bhat SN (2010) Beejamruth: A source for beneficial bacteria. Karnataka J Agric Sci 17:72-77.

Tuzel Y, Oztekin GB and Gul A (2008) Recent Developments in Protected Cultivation in Turkey. 2nd Coordinating Meeting of the Regional FAO Working Group on Greenhouse Crop Production in the SEE Countries, Antalya, pp 75-86.