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STANDARDIZATION OF GROWING MEDIA FOR GROWTH, YIELD AND QUALITY OF SWEET PEPPER (*CAPSICUM ANNUUM*) UNDER SOILLESS CULTURE

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ABSTRACT

The experiment was carried out during the year 2014-2015, in Department of Vegetable Crops, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal to find out the best growing media and variety in soilless culture of Sweet pepper. The experiment was laid out with four replications in Factorial Completely Randomized Design with three different growing media (viz. Cocopeat, Vermicompost, 1:1 mixture of Cocopeat and Vermicompost) and five varieties (viz. Arya, Ayesha, Nikhita, Indra and Mahabharat). Highest plant height of 60.76 cm was observed from the variety Indra. Amongst the varieties the maximum fruit weight of 132 g was obtained from variety Indra. The highest plant height of 63.19 cm, maximum number fruits per plant of 18.13 and highest fruit weight of 137.44 g were obtained with mixture of Cocopeat and Vermicompost. Maximum yield per plant of 1.92 kg and 2.49 kg, respectively were obtained from the mixture of Cocopeat and vermicompost with variety Indra. The variety Indra has shown maximum ascorbic acid and β-carotene content of 70.94 mg/100 g and 220.68 mg/ 100 g, respectively. Best on the results it may be concluded that the variety Indra was found best with 1:1 mixture of Cocopeat and Vermicompost in soilless cultivation.

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INTRODUCTION

Pepper (*Capsicum annuum* L.) is an important vegetable used worldwide for domestic and commercial purposes (Khan *et al*., 2012). It is grown throughout the world for its thick and fleshy fruits having delicate flavour and taste. Cultivation is restricted to the peripheries of big cities in cooler climates. In the last few decades, however, open field/soil based agriculture has been facing some major challenges. Most important among them is the drastic decrease in per capita land availability. This has been attributed chiefly to population explosion, industrialization and rapid urbanization in the past decades. Besides, intensive cultivation of crops in soil following the green revolution has resulted in poor soil fertility, increase in soli salinity and increased occurrence of pathogen infestation. These situations have led to consistent poor yields and quality of food crops. Under such circumstances, in the near future, it would become impossible to feed the entire population using only open field/soil based agriculture. Under such circumstances, soil-less culture can be introduced successfully (Butler & Oebker, 2006) and it is becoming more relevant in the present scenario to cope with these challenges. This system will also help to face the challenges of climate change and also helps in production system management for efficient utilization of natural resources and mitigating malnutrition (Butler & Oebker, 2006). Container culture or substrate culture is indeed the most popular method of soilless culture adopted commercially. One of the most important cultural inputs involved in greenhouse crop production, perhaps is the type of growing media used (Angin *et al.,* 2011). Composted materials have routinely been used as a growing medium or components of growing media by several researchers (Schroeder and Sell, 2009; Nair *et al*., 2011). Soilless growing media are easier to handle and may provide a better growing environment compared to soil (Bilderback *et al.,* 2005; Mastouri *et al.,* 2005). Over the last decades, progress of soilless culture techniques has been rapid in developed countries (USA, Japan, the Netherlands), but its use is still limited in countries like India (Olympios, 1999). In light of this, not much work has been done in our country on this field and information is lacking. The objectives of this experiment was to popularize soilless culture techniques for producing sweet pepper in semi-urban and urban areas to find out the best growing media with respect to growth and yield of sweet pepper under soilless culture.

MATERIALS AND METHODS

The present experiment was conducted under protected conditions (naturally ventilated greenhouse) during Rabi season of the year 2014-15, in humid sub-tropical region of West Bengal under the Department of Vegetable Crops, Bidhan Chandra Krishi Viswavidalayaya, Mohanpur, Nadia. Air temperature and relative humidity inside the greenhouse were recorded every day by means of electronic sensors placed beside the cropped area during the conduct of the experiments. The trial was laid out in Factorial Completely Randomized Design with eight treatments, each replicated four times. In the experiment five promising varieties of capsicum (viz. Arya, Ayesha, Nikhita, Mahabharat and Indra) and three different

combinations of growing media (viz. Cocopeat, Vermicompost and mixture of Cocopeat and Vermicompost in the ratio of 1:1) were used. The aim of the experiment was to select the best performing variety and growing media based on the evaluation of various growth, yield and quality parameters of plants.

Seeds of the selected varieties were sown in 25- cell Po seedling trays on 15th September. The trays were filled with different growing media. After sowing, the seeded trays were incubated for 3 days at 20ºC. When the seeds started germination, the seed trays were shifted to a greenhouse. Standard management practices for soilless cultivation were followed to raise healthy and robust seedlings. Constant concentration of nutrient solution (8 mmols) as reported by Nicola *et al*. (2004) was fed to each tray on third day after transplanting and then once in about 2 weeks, until 15 days before harvesting. Both pH (by pH meter) and electrical conductivity (EC) of the solution were checked two times by following the method stated by Jackson (1973) during the growing period and kept close to the range of 5.5 – 6.5 and 2,000μS cm-1, respectively. The solutions were frequently stirred to avoid algal growth. The polypackets were not kept submerged in nutrient solution for more than two days at a stretch to avoid damping off of seedlings.

The observations were recorded from randomly selected plants. The growth parameters were recorded throughout the growing period of the plants at appropriate stages. While the yield and quality parameters were recorded after the harvest of the crop.

RESULTS AND DISCUSSION

Plant growth characters

Effect of growing media on plant height produced statistically significant variations among the characters. The maximum plant height of 63.19 cm was obtained when plants were grown in the mixture of Cocopeat + vermicompost. Lowest plant height of 55.38 cm was obtained from cocopeat singly as growing media. The highest plant height in the mixture of cocopeat and vermicompost might be due to better physico-chemical properties of the mixture compared to vermicompost and cocopeat individually. Sun-ZhiQiang *et al*. (2003) made similar observations in their study. Plant height due to different varieties showed statistically significant differences. The highest plant height of 60.76 cm was observed in the variety Indra whereas plant height for the variety Ayesha was the lowest (56.10 cm). The result may be due to varying genetic potential of the varieties and their differential response to soilless culture. Regarding the parameter total number of leaves per plant, it can be said that number of leaves per plant among different growing media showed statistically significant differences. Highest number of leaves per plant (65.45) was obtained when the mixture of Cocopeat + vermicompost was used as growing medium. Plants grown only in Cocopeat produced the lowest number of leaves per plant (54.53). The best result of the mixture Cocopeat + vermicompost in both the cases of plant height and total number of leaves per plant may be due synergistic effects of the mixture of growing medium for growth and development of the plants. Gomez-Merino *et al*. (2012) reported that mixtures of cocopeat with other organic substrates produced higher growth and yield in vegetable crops. Indra was significantly the best variety producing an average of 62.11 leaves per plant, followed by Mahabharat which was statistically *at par*. Nikhita produced the lowest number of leaves per plant (57.77). The results may be due to varying genotypic potential of the varieties and their differential response to soilless culture. Albaho *et al*., (2009) reported that vermicompost and cocopeat or mixture in different ratio had significant effects on cultivars heights and number of leaves in pepper. From the Table-1 it is revealed that the highest leaf area of 59.55 cm^2 was observed with the mixture of Cocopeat + vermicompost as growing medium and 57.46 cm^2 of leaf area from the variety Indra, followed by Arya. Experimental result of total number of branches on main stem significantly differed within both varieties and growing media. In this parameter also Cocopeat + vermicompost has shown the best result of 4.66 number of branches per plant. The least number of branches on main stem (3.93) was observed with cocopeat. Several investigators mentioned similar results on different plants such as Kumar and Kohli (2005) in capsicum, Natarajan (2005) in tomato, Bairwa *et al*. (2009) in okra and Roy *et al*. (2011) in capsicum.

Yield and yield attributing characters

It is evident from the Table-2 that there are significant differences among the various growing media for the attribute of days to first flowering. Plants grown in the mixture of Cocopeat + vermicompost took the lowest days to flower i.e. 40 days, while those grown in cocopeat took the longest days to flower of 42.53 days. The result may be due to better nutritional status and uptake in soilless media integrated with organic

Table 1: Influence of growing media and variety on different plant growth characters

Treatments	Plant Height (cm)	Number of leaves per plant	Leaf area (cm^2)	Number of branches per plant
Arya	58.34	58.55	56.83	4.22
Ayesha	56.10	58.33	53.60	4.33
Nikhita	57.75	57.77	53.15	4.00
Mahabharat	59.62	61.22	53.73	4.33
Indra	60.76	62.11	57.46	4.55
C.D. at 5%	1.17	1.79	0.99	N.S.
SEm(±)	0.40	0.62	0.34	0.14
Cocopeat	55.38	54.53	54.83	3.93
Vermicompost	56.97	58.80	50.48	4.26
Cocopeat + Vermicompost	63.19	65.46	59.55	4.66
C.D. at 5%	0.91	1.39	0.77	0.33
SEm(±)	0.31	0.48	0.26	0.11

Table 2: Influence of growing media and variety on different yield and yield attributing characters

Treatments	Days to first flowering	Days to first marketable harvest	Number of fruits per plant	Fruit length (cm)	Fruit diameter (cm)	Pericarp thickness of fruits (cm)	Fruit weight (g)	Yield per plant (kg)
Arya	42.22	85.22	15.00	7.00	5.85	0.74	121.00	1.40
Ayesha	41.22	86.66	14.66	6.93	5.71	0.68	121.33	1.37
Nikhita	41.66	85.31	14.22	6.77	5.55	0.71	118.40	1.37
Mahabharat	40.77	84.11	14.77	6.80	5.71	0.69	117.67	2.28
Indra	40.11	83.77	16.00	7.03	6.08	0.75	132.00	2.49
C.D. at 5%	N.S.	1.55	1. 34	0.11	0.14	N.S	2.81	0.14
SEm(±)	0.60	0.53	0.50	0.03	0.04	0.02	0.97	0.05
Cocopeat	42.53	85.86	12.46	6.59	5.37	0.66	108.93	1.58
Vermicompost	41.06	85.80	14.20	6.96	5.55	0.64	119.86	1.85
Cocopeat + Vermicompost	40.00	82.66	18.13	7.17	6.42	0.85	137.44	1.92
C.D. at 5%	1.35	1.20	1.12	0.08	0.11	0.05	2.17	0.11
SEm(±)	0.46	0.41	0.38	0.03	0.03	0.01	0.75	0.03

Table 3: Influence of growing media and variety on different quality attributing characters

Treatments	Total chlorophyll content (mg/100g)	Ascorbic acid content (mg/100g)	β-Carotene content(mg/100g)	Total soluble solids (^{0}Brix)
Arya	17.32	64.20	190.65	6.14
Ayesha	15.65	66.77	201.36	6.13
Nikhita	15.48	70.66	191.53	6.70
Mahabharat	17.02	67.26	201.15	6.80
Indra	18.06	70.94	220.68	6.25
C.D. at 5%	0.96	1.38	14.79	0.15
SEm(±)	0.33	0.47	5.12	0.05
Cocopeat	16.47	67.55	207.09	6.53
Vermicompost	16.38	65.17	190.78	6.22
Cocopeat + Vermicompost	17.48	71.18	205.36	6.46
C.D. at 5%	0.74	1.07	11.45	0.11
SEm(±)	0.25	0.37	3.96	0.04

amendments like compost (Gowda *et al*, 1998). Regarding the varieties produced non-significant variations in the character. Among them Indra gave the earliest flowers at approximately 40.11 days after transplanting.There was statistically significant effect of different growing media as well as different varieties on days to first marketable harvest and is presented in the Table 2. Plants grown in the mixture of Cocopeat + vermicom post took the lowest days to produce marketable fruits of 82.66 days. This result is with conformation of Indirabai and Sujapratha (2009) and they reported that Vermicompost has high level of nutrients and was able to promote growth, advance flowering and fruiting in the lady's finger. Amongst the Varieties Indra took the least number of days to produce first marketable fruits (83.77 days), followed by Mahabharat. Plants of the variety Ayesha took longest to produce first marketable fruits i.e. 86.66 days. Bhat *et al*. (2013) also reported that vermicompost based growing substrates is superior to other media. Number of fruits per plant was found to be highly significant among the different growing media and varieties. The maximum number of fruits per plant of 18.13 was obtained when the mixture of cocopeat + vermicompost was used as the growing medium. Number of fruits per plant was lowest *i.e.* 12.46 with Cocopeat as growing medium. The result may be due to ideal conditions for good growth of plants in the mixture medium giving way to higher yield. Gungor and Yildirim (2013) also found the same result that mixture of different growing media has a significant effect on total number of fruits per plant in pepper. Amongst the varieties Indra produced the highest number of fruits per plant (16.00), while Nikhita produced the lowest (14.22). It was revealed from the present experiment that the parameters fruit length, fruit diameter and pericarp thickness of fruits differed significantly among different growing media. In all the above mentioned parameters Cocopeat + vermicompost has shown best result than other growing media. Whereas cocopeat singly has shown the poor performance amongst the all media. Fruit length of 7.17 cm, fruit diameter of 6.42 cm and pericarp thickness of 0.85 cm were recorded best from the media Cocopeat + vermicom post. Nagaraj *et al*. (2015) also reported a significant effect of the mixture cocopeat and vermicompost on different fruit characters. Among all the varieties Indra showed the highest fruit length of 7.03 cm, highest fruit diameter of 6.08 cm and maximum pericarp thickness of 0.75 cm. Nikhita produced the lowest fruit length of 6.77 cm. The result is in conformation with Agricola (2009).The results may be attributed to the varying genotypic potential of the varieties and their differential response to soilless culture. The rind thickness of fruit was positively correlated with fruit size, which is to the observation of Naik (2005). Mixture of Cocopeat + vermicompost was the best performing medium recording an average fruit weight of 137.44 g. The least fruit weight (108.93 g) was produced when cocopeat is used as growing medium.

This was may be due to high uptake of nutrients and build-up of sufficient photosynthesis enabled the increase in size of fruits (length and breadth). Similar findings were recorded by Kurubetta *et al.,* 2008. With respect to the varieties fruit weight was highest (62.11g) for variety Indra, followed by Mahabharat which was statistically *at par*. Nikhita gave the lowest fruit weight of 57.77 g. Growing media showed significant effect on the important character of yield per plant. Maximum yield per plant of 1.92kg was obtained from the mixture of Cocopeat + vermicompost as growing medium. While plants grown in Cocopeat produced the lowest yield per plant of 1.58 kg. The result may be due to ideal conditions for good growth of plants in the mixture medium giving way to higher yield. Cadahia *et al*. (1988); Roberts *et al*. (2007); Zaller (2007) and Nagraj *et al*. (2015) also concluded that soilless media has a good effect on yield of different vegetables. Yield per plant differed significantly among the varieties. Indra produced the highest yield per plant (2.49 kg), while Ayesha gave the lowest yield per plant (1.37kg).The result may be due to varying genotypic potential of the varieties along with their varying responses to soilless culture. Vogel and Schodel (1992) concluded that crops grown under soilless culture produced 75% more yield than conventionally produced crops.

Quality attributing characters

It is evident from the Table 3 that total chlorophyll content among different media varied significantly. Maximum total chlorophyll content of 17.48 mg/100 g was observed with the mixture of Cocopeat + vermicompost as growing medium. While the lowest total chlorophyll content of 16.18 mg/100g was seen with vermicompost as growing medium. The chlorophyll is an essential component for photosynthesis occurs in chloroplasts a green pigents in all photosynthetic plant tissues, so more chlorophyll content in plants may be attributed to more uptake of nitrogen by the plants (Malik *et al*. 2011).The character also differed significantly among the varieties. Indra gave the highest total chlorophyll content (18.06 mg/100g) followed by Arya which was statistically *at par*. Nikhita showed the lowest value for the character (15.48 mg/100g). Albaho *et al*. (2009) reported that different growing had significant effects on chlorophyll index of pepper. Cocopeat + vermicompost was the best performing medium with 71.18 mg/100g of ascorbic acid content. Vermicompost showed the lowest ascorbic acid content (65.17 mg/100g).Varieties also produced significant variations among the character. Variety Indra showed the highest ascorbic acid content of 70.94 mg/100g, while Nikhita was statistically *at par*. Arya produced the lowest value for the character (64.20 mg/100g). Padem and Alan (1994) reported that growing media statistically affected ascorbic acid values and TSS of pepper cultivars. The maximum β-Carotene content of 207.09 mg/100g was obtained when plants were grown in Cocopeat, followed by cocopeat + vermicompost which was statistically *at par*. Vermicompost showed the lowest value for the character (190.78 mg/100g of β-Carotene content). Significant difference in β-Carotene content was observed in response to different varieties and maximum β-Carotene content of 220.68 mg/100g was found with the variety Indra. Regarding total soluble solids Cocopeat as growing medium produced the highest total soluble solids (6.53°Brix) and Cocopeat + vermicompost was statistically *at par*. Vermicom post showed the lowest total soluble solids of 6.22 °Brix. The results are in conformity with the findings of Asano (1994). Among all the varieties Mahabharat produced the highest total soluble solids (6.80 °Brix) .While, Ayesha gave the least value for the character (6.13°Brix). Gullo (2006) evaluated soilless cultivation system by using different substrates for producing early vegetable crops of high quality. Gruda (2009) strongly suggests changes in the quality parameter of many vegetables in response to the growing medium used.

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